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㊹発明の名称　多位置制御装置

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明　細　書

1. 発明の名称

多位置制御装置

2. 特許請求の範囲

(1) 外力に応動して所望位置へ移動するように可動に支持された可動部材の位置制御を行なう多位置制御装置であつて、

該多位置制御装置は

(a) 磁界発生手段と、

(b) 前記可動部材に係合され且つ前記磁界発生手段により生じる磁界中に該磁界の向きと交叉するように巻装された複数の電気導体群からなり該電気導体群に流れる電流により生じる力を前記可動部材に伝える電気導体系と、

(c) 前記電気導体群に接続され該電気導体群に流す電流の大きさ及び方向を設定する電流供給手段

とからなることを特徴とするもの。

(2) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

(a) 棒状の永久磁石と、

(b) 前記永久磁石の一方の磁極部分に連結され且つ前記永久磁石の他方の磁極部分と対向する位置にその端部と異極の磁極が現われるように配置された継鉄とからなることを特徴とするもの。

(3) 特許請求の範囲第2項記載の多位置制御装置であつて、

前記電気導体系は

(a)前記鉄芯の外周に摺動自在に嵌挿された電気磁導性導体と、

(b)前記電気磁導性導体に巻装された通電導線と

からなることを特徴とするもの。

(4) 特許請求の範囲第2項記載の多位置制御装置であつて、

前記電気導体系は

(a)前記鉄芯外周に摺動自在に嵌着された電気磁導性導体と、

(b)前記磁導性導体に巻装された通電導線と、

(c)前記導線への電流の供給を停止したときに前記導体を前記鉄芯の略中央位置に復帰させる復帰手段とからなることを特徴とするもの。

(5) 特許請求の範囲第4項記載の多位置制御装置であつて、

前記復帰手段は

(a)前記両端に立設された軸に巻装され前記磁導性導体が前記導線に流れる電流の方向に応じて移動すると弾発力が生じるように配置されたコイル状ばねからなることを特徴とするもの。

(6) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

相対向して配置された一対の永久磁石からなり前記電気導体系は

(a)前記一対の磁石間に軸支されその長手方向に沿つて延設された回転軸と、

(b)前記回転軸長手方向に装着された磁導性導体と、

(c)前記磁導性導体長手方向において前記一対の磁石の磁極と対向するように巻装された通電用線と

からなることを特徴とするもの。

(7) 特許請求の範囲第6項記載の多位置制御装置であつて、

前記可動部材は被物品に所定形状の経路内を往復運動するように支持された弁からなり、

前記電気導体系は

(a)前記回転軸と並行に立設されたピンと、

(b)前記可動部材の弁の略中心位置に設け前記ピンが係合され前記導線に電流が流れた時の前記磁導性導体の回動運動を直線運動に切り換える凹状の溝と、

(c)前記回転軸に巻装されその端部が前記ピンを挟み前記導線に流れる電流を切つた時、前記磁導性導体がその前記一対の磁石の磁極と対向する位置に戻るようにするばね

とからなることを特徴とするもの。

(8) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

(a)一対の永久磁石と、

(b)前記一対の磁石間に軸支された回転軸に装着され前記電気導体系の導体線に電流を流した時電磁誘導により電磁石となり前記一対の磁石の磁極と吸引反発する鉄心とからなることを特徴とするもの。

(9) 特許請求の範囲第8項記載の多位置制御装置であつて、

前記鉄心は

前記回転軸と同軸に装着された断面略円形状の鉄部材からなり、

前記電気導体束は

前記鉄部材の外周を断面略長方形状に巻装され電流を切つた時には該断面長方形状の中心と前記回転軸と前記回転軸断面中心とを結ぶ線と直交する線上の前記断面円形状の鉄心の両端部は前記一対の磁石の端部が対向する空隙部分と対向する位置に中立位置として静止させる復帰構成からなることを特徴とするもの。

(10) 特許請求の範囲第8項記載の多位置制御装置であつて、前記鉄心は

(a) 前記回転軸を中心に大略120°間隔で前記回転軸半径方向に3つに分岐され且つ分岐された3つの各々の端部が更に断面略三日月状に分岐され、

(b) 前記電気導体束の導体線に電流が流れていない時前記3つに分岐された鉄心端部のうち第1及び第2の端部から前記断面三日月状に分岐された先端は前記一対の磁石の大略中心部の曲線に対向する位置まで磁石表面に沿つて延設され、

(c) 前記3つに分岐された鉄心の端部のうち第3の端部は前記一対の磁石の端部が互いに対向する一方の空隙と対向する位置に中立位置として延設されており、

前記電気導体束は

(a) 前記鉄心の第1の端部と第2の端部とには同種の磁極を前記鉄心の第3の端部には前記第1及び第2の端部と異種の磁極を生じるように前記3つに分岐された鉄心に巻装されている復帰構成からなることを特徴とするもの。

(11) 特許請求の範囲第8項記載の多位置制御装置であつて、

前記鉄心は

中心部が前記回転軸に装着された薄い肉厚の鉄板からなり且つ前記鉄板の両端部が断面略三日月状となり前記一対の磁石の表面に沿つて延設されており、

前記電気導体束は

前記鉄板の両端部間に巻装され電流の流れていない時は前記鉄板の両端部が前記一対の磁石の端部が互いに対向する空隙部分に対向する位置に中立位置として静止させる復帰構成からなることを特徴とするもの。

(12) 特許請求の範囲第9項から第11項までのいずれかに記載の多位置制御装置であつて、

前記電気導体束は

前記導線に流れる電流を切つた時前記鉄心が前記中立位置に戻るように前記回転軸に装着されたばねを有することを特徴とするもの。

(13) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

(a) 一対の永久磁石と、

(b) 前記一対の磁石間に軸支された回転軸に装着され前記電気導体束の導体束に電流を流した時励磁作用により電磁石となり前記一対の磁石の磁極と吸引反発する鉄心と、

(c)前記鉄心に装着され前記鉄心と当接する部分が断面略凹状の溝部を有し前記凹状の溝の両端部から前記一対の磁石の各磁面に沿つてその中心磁極に向かつて延設された断面略円弧状の張り出し部を有する一対の鉄片とからなり、

前記電気導体束は

(d)前記一対の鉄片の断面円弧状張り出し部と前記鉄心の端部との間に巻装された複数個の巻線とからなることを特徴とするもの。

(14) 特許請求の範囲第13項記載の多位置制御装置であつて、

前記鉄片の凹状の溝部は前記巻線に流れる電流を切つた時に前記一対の磁石の端部が対向する空隙部分に対向する中立位置に戻り且つ前記巻線に電流を流した時前記中立位置から大略60°回動すると静止するように前記電流供給手段の最大電流を設定していることを特徴とするもの。

(15) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

(a)一対の永久磁石と、

(b)前記一対の磁石間に軸支された回転軸に装着され前記回転軸を中心に大略120°間隔で半径方向に3つに分枝された端部を有し前記3つに分枝された端部のうち2つは断面略三日月状に分枝されており前記電気導体束の導体線に電流が流れていない時には前記端部の断面三日月状に分岐された先端が前記一対の磁石の中心磁極に対向する位置まで延設され前記断面三日月状に分岐されていない端部は前記一対の磁石の端部が互いに対向する一方の空隙部分に対向する中立位置に静止されている鉄心とからなり、

前記電気導体束の導体線は

前記断面三日月状を形成する前記鉄心端部と前記断面三日月状を形成しない端部とは互いに異極の磁極を生じるように前記鉄心端部間を巻装してなる複数個の巻線からなることを特徴とするもの。

(16) 特許請求の範囲第1項記載の多位置制御装置であつて、

前記磁界発生手段は

(a)一対の永久磁石と、

(b)前記一対の磁石間に軸支された回転軸に装着され前記電気導体束に電流を流した時に励磁作用により電磁石となりその時発生する磁極が前記一対の磁石の持つ磁極と吸引反発し該磁気の吸引反発により生じる力の方向と前記電気導体束に流れる電流が前記一対の磁石によつて生じる磁界により生じる力とが同一方向となるように形成され且つ前記電気導体束に流れている電流を切つた時元の中立位置に戻るように形成された一対の鉄片とからなることを特徴とするもの。

(17) 特許請求の範囲第16項記載の多位置制御装置であつて、

前記一対の鉄片は

前記回転軸を中心にして互いに対称を有して延設され各々の両端部から前記一対の磁石の磁面に対向するように断面円弧状に形成された2つの鉄部材からなり、

前記電気導体環は前記2つの磁極材の対向端部間を前記回転軸を挟みつつ巻装された板状導体からなることを特徴とするもの。

(18) 特許請求の範囲第16項記載の多位置制御装置であつて、

前記一対の鉄片は中心が前記回転軸に接着された凹凹H字型形状となつていることを特徴とするもの。

(19) 特許請求の範囲第18項記載の多位置制御装置であつて、

前記一対の鉄片の厚さは前記電気導体環に流す電流値に応じて設定され且つ前記電気導体環に電流を流している時の発生する前記電流による力と磁界の吸引反発力に影響しないよう電流を切つた時発生する元に戻ろうとする力が発生するように設定されていることを特徴とするもの。

(20) 特許請求の範囲第2項記載の多位置制御装置であつて、

前記電気導体環は

(a)前記磁極外周に沿つて揺動自在に支持された電気絶縁材からなるスペーサ部材と、

(b)前記スペーサ部材に装着され前記一対の磁石間に介装された電気導体材からなるボビンと、

(c)前記ボビンにその両端面が互いに逆極の磁極が生じるように巻回された導電体線とからなることを特徴とするもの。

(21) 特許請求の範囲第1項から第20項までのいずれかに記載の多位置制御装置であつて、前記可動部材は

走行玩具の一対の従動輪の方向を左右及び直進位置に変換する方向変換装置を構成し、該一対の従動輪の車軸と係合する軸受台に両端がそれぞれ回動自在に支持された連接棒からなり、

前記電気導体環は前記導体環に電流が流れていない時前記一対の従動輪が直進位置となるように前記連接棒の中央部と係合されていることを特徴とするもの。

(22) 特許請求の範囲第6項から第19項までのいずれかに記載の多位置制御装置であつて、前記可動部材は

走行玩具の一対の従動輪の方向を左右及び直進位置に変換する方向変換装置を構成し、該一対の従動輪の車軸と係合する軸受台に両端がそれぞれ回動自在に支持された連接棒からなり、

前記回転軸と突設されたピンと前記連接棒の中央部に凹設された溝とにより前記回転軸の回転運動に対して前記連接棒が往復運動に変わるように係合されていることを特徴とするもの。

(23) 特許請求の範囲第1項から第5項まで及び第20項のいずれかに記載の多位置制御装置であつて、前記可動部材は

走行玩具の一対の従動輪の方向を左右及び直進位置に変換する方向変換装置を構成し、該一対の従動輪の車軸と係合する軸受台に両端がそれぞれ回動自在に支持された連接棒からなり、

前記電気導体環は

前記連接棒の中央部に立設されたピンに係合され前記電気導体環の往復運動を前記連接棒に伝える電気絶縁性部材を有することを特徴とす

るもの。

3. 発明の詳細な説明

産業上の利用分野

本発明は、外力に応動して所望位置に移動するように動的に支持された多位置制御装置に関し、特に無線又は有線によるコントロールカー等の走行玩具の従動輪（前輪又は後輪）の車軸を同時に回動させ車体を方向変換させる方向変換装置等に適用される多位置制御装置に関する。

従来の技術

従来、ラジオコントロールカーの方向変換装置としては、①従輪を駆動輪としてその各々の車軸を差動装置（デイファレンシャルギヤ）と連結させモーターで回転駆動をさせると共に各々の軸に個別的に制動を加える例えば電磁石と磁性材からなるブレーキ装置を配設し、いずれか一方の前輪に駆動力を上回る強い制動力を加えて左右いずれかの方向に車体を方向変換されるもの。又は、②従輪を駆動輪としてモータで回転させると共に、該モータにより従動輪である前輪を通して車体の方向変換を計る操舵機構を内蔵したもの等が提案されている。

しかしながら、上記①の方法を用いた走行玩具に於ては、走行方向変換装置として差動装置や電磁式のブレーキ機構が必要となり、場所をとり又高価なものとなつた。

更には、構成が複雑で製造に手間がかかり、故障もし易い欠点を有していた。一方、上記②の方法を用いた走行玩具に於ては、上記①の場合に於した欠点は幾分解消されるものではあるが、方向変換が円滑でなく騒音が激しく又電流消費も多く効率が悪いという欠点を有していた。

発明が解決しようとする問題点

本発明は、上記欠点に鑑み上記欠点を解消した多位置制御装置、即ち小スペースで簡単な構成で且つ安価でありしかも方向変換が円滑で騒音が少なく電流消費の少ない高効率のよい多位置制御装置を提供することを目的とする。

問題点を解決するための手段及び作用

上記問題点を解決するために、本発明に係る可動部材の多位置制御装置は、例えば永久磁石又は電磁石からなる磁界発生手段により生じた一定磁界中にエナメル被覆線材の如き導体線をボビン等の回りに巻回してなる電気導体束を配設し該電気導体束に大きさ又は方向のいずれかが可変の電流が流れるようになつている。このため電流供給手段から上記電流を流すと該電気導体束には該電流の方向と磁界の方向とのそれぞれに直交する方向に所謂電磁力F_1が生じる。該電磁力F_1により該電気導体束が移動し該電気導体束の移動に応じて該電気導体束に連結した可動部材が所定位置に移動するように構成しているので、電流の大きさ及び方向を適切に変えれば可動部材の多位置制御が可能となるものである。

更に、上記構成の磁界発生手段に磁束を加えることにより磁界密度を上昇させれば、上記電磁力F_1が大きくなりより細かな多位置制御が可能となる。

又、上記電気導体束に鉄心を介挿させて磁気的結合により電磁石を形成し上記磁界発生手段のもつ

磁極との吸引反発力 F_2 と上記電磁力 F_1 との合成力 F_1+F_2 をもつて磁電気導体系従つて可動部材を移動させればより強力に該可動部材を移動させることができ迅速で確実な多位置制御が可能となる。

その際、鉄心の形状を適切に設定すれば、磁電気導体系に流れている電流を切つた時磁電気導体系自らが元の位置に復帰することができるようになつている。

実施例

以下、本発明に係る物品の可動部材の多位置制御装置の実施例を図面を参照しつつ説明する。

尚、図中同一符号は同一構成要素を示す。

第1図は、本発明に係る多位置制御装置の第1実施例を示す断面図である。

第1図に於て、符号1は例えば円筒状の鉄製容器を示し、符号2a，2bは該容器1に装着された断面C字型の一対の永久磁石を示し各々容器内側と外側とで磁極が異なつている。即ち例えば図に示したように、上側の磁石2aでは内側にN極外側にはS極が現われ下側の磁石2bでは内側にS極外側にN極が現われる。又、容器1が鉄製であるため磁路が形成され各磁石2a，2bの中心位置は最も磁力線が強くなつている。符号3a，3bは継鉄を示しそれぞれ該容器1を介して該永久磁石2a，2bに連結されており好ましくは対向空隙を有して該永久磁石2a，2bの外側の磁極と同一磁極を持つように磁路が形成されている。該一対の継鉄3a，3bは好ましくは該容器1と同軸円筒状となつている。更に符号4は好ましくはプラスチック製の円筒状巻体を示し該永久磁石2a，2bと継鉄3a，3bとの間に介挿され該継鉄3a，3bに摺動自在に支持されている。該巻体4には二相式又は三相式に好ましくはエナメル被覆の銅製細線（以下単に銅線という）が巻装されており、端部が該容器1から取り出され外部の直流電源（図示せず）に切換スイッチを介して接続されている。該スイッチは好ましくは操作者により電源オン，オフを行なう機能と該銅線に流す電流方向切換を行なう機能を有しているものが使用されている。電流の大きさを可変にする機能を設けてよいことは勿論である。又、該銅線を外部による入力信号により該銅線に流す電流を制御する制御ユニットに接続してもよい。尚上記巻装された銅線と巻体4とにより磁電気導体系5を構成する。又、巻装方向は該永久磁石2a，2bと継鉄3a，3bの作る空間磁界と大略直交している。

第2図は、第1図に示す多位置制御装置の側面断面図であり例えば、走行玩具である物品6に支柱6aにより固定支持されている。該物品6の例えばタイロッドの如き可動部材7に連設されたピン7aと上記磁電気導体系5とは容器1に設けた長手穴を介して適当な継手部材8により係合している。

上記構成の多位置制御装置に於て、銅線に流す電流がオフ状態のとき第1図に示す位置即ち中立位置 N_T に該磁電気導体系5を配置し、図の矢印ⓐで示す方向に電流を流せば、該電流の大きさ及び磁界の強さに応じて該磁電気導体系5は図の方向に力 F_1 が生じる。この力 F_1 によつて該磁電気導体系

5は磁性鉄3a，3b上を右手方向に摺動する。従つて、該電気導体束5に係合した上記可動部材7も右手方向に移動する。又、電流方向を逆にすれば、該電気導体束5は左手方向に移動する。尚、電流をオフにした時、該電気導体束5は移動方向した位置で停止するので、第1図に示す中立位置NTに強制的に戻るように、上記部品6には復帰ばね9の端部9a，9bが上記ピン7aに直交して係設されている。このばね9により可動部材7及び電気導体束5が電流オフ状態では常に上記中立位置NTに来ることとなる。この様にすれば、可動部材は少なくとも2位置制御が可能となる。更に、電気導体束5に流れる電流の大きさを可変にすれば2位置以上の位置制御が可能となる。

第3(a)図と、第3(b)図及び第3(c)図と、第4(a)図、第4(b)図及び第4(c)図は本発明に係る他の実施例を各々示す。

尚、上記多位置制御装置に於る磁石と磁鉄の組合せの他の実施例を第3(a)図、第3(b)図、第3(c)図及び第5図に示す。

第3(a)図の第2実施例に於ては、上記円筒状容器1の底面壁1a及び上面壁1b内側に一対の磁石2a，2bを例えばそのS極が容器1の壁部と当接しN極が互いに磁鉄3a，3bを介して対向するように配設したものである。その他の構成は第1実施例と同じである。

第3(b)図に示す第3実施例及び第3(c)図に於ては、円筒状容器1の底面壁及び上面壁1a，1bを取りはずし、その部分に容器内径と等しいドーナツ状磁石2a，2bを嵌合させ該磁石2a，2bの中央穴部に磁性鉄3a，3bを容器内略中央部で対向するように嵌合したものである。その他の構成は第2実施例同様第1実施例と同じである。

第4(a)，4(b)及び4(c)図に示す第4実施例に於ては、円筒状金属製容器1の代りに六面体即ち角型にしたものであり更に、電気導体束5、磁石2a，2b、及び磁鉄3a，3bも角型にしたものである。これにより更に安定性が増し為めに上記部品6と接触しあく上記支柱6aを設ける必要はなくなる。

又、第1実施例から第4実施例までに於ては、磁界を発生するための手段として一対の永久磁石2a，2bを用いたが、これに限らず電磁石構成としたものにより発生させてもよい。

尚、上記第1実施例から第4実施例に於ては、各々構成上磁鉄3a，3bを使用しているが、1個の永久磁石を用いその永久磁石の長手面に沿つて上記電気導体束5を摺動自在に支持させた構成でもよいことは勿論である。

尚、本実施例の場合、可動部材7とは可動部材7の中央位置に凹部7bに板材8が係合している。

第5図は、本発明に係る多位置制御装置の第5実施例を示す正面図である。

本実施例に於ては、上記容器1の中心軸に沿つて回転軸10が軸支されており、符号4で示す上記導体であつて断面略長方形状のものが固定されている。永久磁石2a，2bはそれぞれN極S極が容器内側に生じているものとする。又、上記軸は該導体長手方向に沿つて摺動されている。

第5図に示す位置で電流を⊗と⊙で示す方向に

流すと、上記力F_1が生じ、該導体4は回転軸10と共に反時計方向に回動することとなる。又、逆方向に電流を流すと時計方向に回動する。この回転軸10及び導体の回動運動を上記可動部材7に適当に伝えれば、多位置制御が可能である。尚、可動部材7が往復運動する場合には上記回動運動を往復運動に変換する機構を設けるとよい。本実施例に於てもばね等の復帰手段を用い、該電気導体束5に電流の流れていない場合等に第5図の位置に来るよう設定すればよい。

第6(a)図及び第6(b)図は、本発明に係る多位置制御装置の第6実施例を示す。

本実施例に於ては、上記第5実施例に示す導体4の構成と異なり上記回転軸10の回りに断面円形状の軟鉄製鉄心11が装着されている。該鉄心11の巻き方向に上記線材が巻装されている。尚、上記第5実施例と同様該回転軸10端部には該回転軸10と直交する突手板13が延設され且つその端部にはピン12が該回転軸10と並行に立設されている。

上記の構成をした本実施例の多位置制御装置に於て、第6(b)図に示す様に、該電気導体束5の該一対の磁石2a,2bのうち上部側の磁極N極側の対向箇所に⊗で示す方向に電流を流す。一方、該電気導体束5の該一対の磁石2a,2bのうち下部側磁極S極側対向箇所には⊙で示す方向に電流が流れる。すると、該一対の磁石2a,2b間の磁束の方向と該電気導体束5に流れる電流の方向とに直交する方向即ち反時計方向に上記実施例同様電流力F_1が生まれる。更に、該鉄心11の左右端面には磁極N,Sが発生する。即ち、該電気導体束5を形成する上記線材に電流を流すことにより磁界が発生しその磁気誘導作用により該鉄心の左右端面に電流方向に応じて異なる磁極が現われ鉄心自体が電磁石となる。このため左側端面に現われた磁極N極と該一対の磁石2a,2bの下部側の磁極S極とは吸引し合い又該一対の磁石2a,2bの上部側の磁極N極とは反発し合う。一方右側端面に現われた磁極S極と該一対の磁石2a,2bの下部側の磁極S極とは反発し合い又該一対の磁石2a,2bの上部側の磁極N極とは吸引し合う。この吸引反発力F_2の方向は上記電流力F_1と同じ反時計方向であるためその合成力F_1+F_2により、該電気導体束5と鉄心11と共に該回転軸10は図の実線矢印方向即ち反時計方向に回動する。この時、該回転軸10の反時計方向の回動に伴ない該回転軸10と並行に延設したピン12が回動しそれに伴い該可動部材7も移動する。即ち右方向に移動するのである。尚、該回転軸10の回動角度は該電気導体束5の線材の巻数及び電流の大きさにより最大90度。即ち、該鉄心11の左右端面に現われた磁極N,Sが該一対の磁石2a,2bの中心にある磁極N,S極に対向する位置に来る迄である。

次にこの状態で切換用スイッチを切る。即ち、該電気導体束5の線材に流れている電流を遮断すると、本実施例に於ては後述するニュートラル力F_3が働かないのでそのままの位置で停止することとなる。

そこで本実施例に於ては該回転軸10と上記物品

6に設けた凹部と係止ピン12に巻装したコイル状ばね9のばね力により第6(a)図に示した位置N_Tに復帰されるのである。一方、該電気導体束5の第一対の磁石2a，2bの上端側の磁極N極側対向箇所に今度は上述の場合と逆方向に電流を流すと、上記電流力F_1は上述の場合とは逆方向即ち時計方向となり且つ該鉄心11の左右端面の磁極は逆となり上記吸引反発力F_2も時計方向となり結局該回転軸10は図示の点線矢印方向即ち時計方向に回動する。従つて、該復帰ばね9により中立位置に来た電気導体束5は逆方向即ち左手方向に移動することとなる。

以上の如く、本実施例の多位置制御装置により可動部材7の多位置制御が可能となる。又、本実施例は上記電流力F_1に加え磁界の吸引反発力F_2を利用しているため該可動部材7を移動させる力は更に強力なものとなるので該可動部材7はより確実に迅速に移動できる。

又、電気導体束5及び鉄心11は同時に電流を流さない状態では第6(a)図に示す位置に設定する必要がある。もし、第6(a)図に示す電気導体束5を第一対の磁石2a，2bの空隙側に対向させ鉄心11の左右端面を該磁石2a，2bの中心磁極側に対向配置した状態を中立位置として電流を流した場合、該回転軸22がどちらの方向に回動するのか確定できないことと、上記電流力F_1が上記吸引反発力F_2方向に加わらないからである。

第7(a)図及び第7(b)図に本発明に係る多位置制御装置の第7実施例を示す。

本実施例に於て、上記可動部材7との係合方法は上記第5及び第6実施例と同様であるので説明は省略する。

第7(a)図に示す様に鉄心11を大略120°間隔で半径方向に回転軸10から延設し各3つの磁極11a，11b，11cを三日月状断面形状にし、そのうち磁極部11aの一方の三日月状断面磁端を大略該一対の磁石2a，2bの上部側の中心磁極N極に対向させ他方の三日月状断面磁端を該磁石2a，2bの上部側の右端に対向させ、又磁極部11bの一方の三日月状断面磁端を該磁石2a，2bの下部側の右端に対向させ他方の三日月状断面磁端を該磁石2a，2bの下部側の中心磁極S極に対向させ、磁極部10cの両方の三日月状断面磁端をそれぞれ該磁石2a，2bの中心磁極N極及びS極と左側端部との間の中間位置に対向配置させている。

又、上記銅線を第7(a)図に於て例えば磁極部11aの右側より⊙に示した方向で更に磁極部11bの左端まで⊗に示した方向で鉄心長手方向に沿い巻着し次に磁極部11aの右側⊙の示した部分から磁極部11cの上側⊗で示した方向から磁極部11cの下側⊙で示した方向で鉄心長手方向に巻付し次に磁極部11bの上側⊗で示した方向から該磁極部11bの下側で⊙で示した方向で鉄心長手方向に沿い巻着し終り容器1の筐体14の穴から容器1外側に引き出す。従つて、磁極部10aの右側の巻線に⊙方向の電流を流せば磁極10aには電磁誘導によりS極が磁極部10bにはS極が磁極部10cにはN極がそれぞれ現われる。

上述の如く、電流を流した場合、鉄心11の両端部11a，11bには磁気誘導により磁極S極、中央部11cには磁極N極が生じる一方、電磁力F_1は各端部11a，11b，11c周囲の巻線方向により電気導体束18各部で相違するが全体の合成結果として第7(a)図に於て実線矢印方向即ち反時計方向となる。又、磁気誘導により生じた各端部11a，11b，11cの磁極と該一対の磁石2a，2bの磁極との異極磁極間の吸引力及び同極磁極間の反発力F_2が上記電磁力F_1の方向と同一方向に働らく。従つて上記電磁力F_1と吸引反発力F_2との力により電気導体束5と鉄心11は反時計方向に回動することとなる。この反時計方向の移動限度であるが、該端部11cが該一対の磁石2a，2bの左側空間の対向位置即ち該鉄心11の中立位置N_Tから該端部11cが磁力線の最も密度の高い該一対の磁石2a，2bの下部側の中心磁極S極の対向位置に来たとき最大移動位置となる。この場合、該端部11cの三日月状断面の両突起により下部側磁石2aの中心磁極S極との対向面積は鉄心途中の断面積よりも大きいので該端部11cを通過する磁力線は多くなる。従つて該一対の磁石2a，2bと該鉄心11からなる系の位置エネルギとしては低いものである故、後述するニュートラル力F_3は生じない。従つて、この状態で該電気導体束5の両端に流れる電流を切るとその状態で停止する。従つて該電気導体束5、鉄心11、及び回転軸10からなる回転子を上記中立位置（第7(b)図で示す位置に）N_Tに戻すため上記第5及び第6実施例と同様ばね9を設けてそのばね力により戻しているのである。

次に該電気導体束5を構成する両端に流れる電流を上記の場合と逆にすると、鉄心11の両端部11a，11bには今度はN極が現われ中央部11cにはS極が生じる。この場合、電磁力F_1及び磁気の吸引反発力F_2は共に第7(b)図の点線矢印方向即ち時計方向の向きとなる。従つて上記回転子は時計方向に最大90°回動する。この様に最大ストローク180°の範囲内での回転子の回動が得られ上記可動部材7の位置制御が可能となる。

第8図は、本発明に係る多位置制御装置の第8実施例を示す。容器1と磁石2a，2bと回転軸10から可動部材7までの構成は上記実施例に示したものと同様であるので、説明を省略する。

本実施例に於ては、丁度上記第7実施例を示す第7(a)図及び第7(b)図の右側の両端部11a，11bを結合して左側の端部11cと反対側に配置した鉄心構造のものと考えて差しつかえない。

又、該三日月状断面を有する鉄心11の端部間11a，11cに上記巻線からなる電気導体束5を容器1長手方向に巻回して回転子とし、第8図に示す中立位置N_Tに該回転子を配置する。第8図に示した中立位置状態から図示の電気導体束5の上側即ち該一対の磁石2a，2bの上部側2a対向側に⊗で示す方向に又電気導体束5の下側即ち磁石2a，2bの下部側2a対向側に⊙で示す方向に電流を流すと該鉄心11の左側端部11aには磁気誘導によりN極が右側端部11bにはS極が現われ、反時計方向に生じる電磁力F_1と共に該磁石2a，2bとの磁気吸引反発力F_2が生

に図の実線矢印方向即ち反時計方向に該回転子が回転軸10を中心に回動する。又、電流の方向が上述の場合と逆であれば図の中立位置N_Tから点線矢印方向即ち時計方向に回転軸10を中心に回動する。上記電磁力F_1及び磁気吸引反発力F_2は回転子を図の中立位置N_Tに固定するばね（図示せず）のばね力に逆つて回動することは勿論である。

第9図には、本考案に係る多位置制御装置の第9実施例を示す。

本実施例に於ては、第9図に示す一対の断面略クランク状のニュートラル用鉄片14a，14bを鉄心11に設けた透孔11dに結合ピン15でかしめ加工して左右対称に連結している。又、該鉄心11の外周で該ニュートラル鉄片14a，14bの対向する部分に上記巻線を巻回した電気導体束5を形成している。該鉄心11の中心を該結合ピン15を貫いて該容器1の中心の軸孔（図示せず）と該容器1の蓋側の蓋体（図示せず）の軸孔に嵌合させている。該鉄心11，ニュートラル用鉄片14a，14b，電気導体束5，回転軸10，及び結合ピン15からなる回転子が第9図に示す中立位置N_Tに来るように設置する。この時一方のニュートラル用鉄片14a，14bの中心凹部が該一対の磁石2a，2bの端部対向部分に位置している。

第9図に示す状態で、該一対の磁石2a，2bの上部側2aに対向する電気導体束5には⊗で示す方向に下部側2bに対向する電気導体束5には⊙で示す方向に電流を流すと該鉄心11の左右切削部分から該クランク状断面の該ニュートラル用鉄片14a，14bに磁路が出来該鉄片14a，14bに沿つて図示の如く磁極N極及びS極が現われる。上述の実施例と同様電磁力F_1と異極磁極同志の吸引及び同極磁極同志の反発による力F_2とが発生し、該電気導体束5，該ニュートラル用鉄片14a，14b等から構成される回転子は図の実線矢印方向即ち反時計方向に回動する。そして、電流の大きさによつては該一対のニュートラル用鉄片14a，14bの凹部が該一対の磁石2a，2bの磁力線の最も密度の高い部分即ち磁石の中心磁極である図のN極及びS極のそれぞれ対向する位置即ち90°の位置まで来る。しかしながら、その時には磁路の断面積は該一対のニュートラル用鉄片14a，14bの凹部の断面積と該鉄心の断面積の差が大きくなるので磁気抵抗は小さくなる。従つて該一対の磁石2a，2b及び該回転子からなる系の位置エネルギは低くなる故、この位置で電流を切つた場合該回転子は元の中立位置N_Tに戻らなくなる。上記系の位置エネルギが最大になる所謂死点は該一対のニュートラル用鉄片14a，14bの断面円弧上の端部14aa，14bbが該磁石2a，2bの端部$2a_1$，$2b_1$付近に来た時である。

即ち、該中立位置N_Tを0°とした場合、大略60°付近となる。この時には、該一対のニュートラル用鉄片14a，14bの断面円弧部分が該一対の磁石2a，2bの中心磁極N極及びS極の対向位置に来ているので該ニュートラル用鉄片円弧部分の断面積と該鉄心の断面積との差は最小とな

り磁気抵抗は大きくなる。（磁気抵抗は磁路長に比例し磁路断面積に反比例する関係がある）。従つて系のもつ位置エネルギは最大となる。尚、回転子が第9図に示す中立位置N_Tに在る時は第一対の磁石2a，2bの端部と第一対のニュートラル用鉄片14a，14bの凹部を通じて磁路が形成されるが、磁極奥行方向の断面積は大きいので磁気抵抗は小さく従つて系のもつ位置エネルギは小さい。このため、回転子が60°回動即ち上記死点に到達した時点で位置エネルギ　の低い所即ち上記中立位置N_Tへ戻ろうとする力であるニュートラル力F_1が起こる。従つて、上記死点に回転子が到達した所で回転子を停止するように設定すれば、電流を切ると、回転子は該ニュートラル力F_1で自然に該中立位置N_Tに戻るわけである。本実施例の場合は、上記実施例に示した様なばね9を用いて回転子を中立位置N_Tに強制的に戻す特別な復帰手段は不必要となる。又、電流を切り換えると、中立位置N_Tから図示の点線矢印方向に即ち時計方向に回転子は回動するので中立位置N_Tから両方向大略60°迄のストローク範囲を利用すれば可動部材の位置制御が実現できる。

第10図は、本発明に係る多位置制御装置の第10実施例の断面図を示す。本実施例に於る駆動装置の内部構成は第7(a)図及第7(b)図に示す第7実施例に近いものである。即ち、第7(b)図に示す鉄心端部11cに在る三日月断面形状の突起を取り外したものに相当する。又、本実施例は、上述の第9実施例同様ばね9等回転軸10に復帰手段を設ける必要はない。

又、本実施例の場合、図の⊙及び⊗に示す方向にそれぞれ第6実施例の説明で述べた如くに流すと鉄心各端部11a，11b，11cにそれぞれ磁極S極，S極及びN極が現われ反時計方向に回転子が回動するが、系のもつ位置エネルギは鉄心端部11cが中立位置N_Tから90°位置に来ると磁路の断面積は最小となり磁気抵抗が最大となり従つて該位置エネルギは最大となる。従つてニュートラル力F_1が起きて電流を切ると中立位置N_Tに回転子が戻る。本実施例に於ては、以上説明した様に上下90°迄回動することとなるが勿論ストロークの範囲を上記第10実施例の如く上下60°に設定しても問題はない。

第11図は、本発明に係る多位置制御装置の第11実施例の断面図を示す。

本実施例の最大ストローク範囲は上記第10実施例と同じく中立位置N_Tから上下90°の範囲である。勿論上下60°の範囲をストローク範囲にして可動物体6の位置制御は可能である。

又、一対のニュートラル鉄片14a，14bに介装している一対の鉄心11a，11bを取り外し90°に回転子が回動した場合磁気の吸引反発力F_2は弱まりニュートラル力F_1は大きくなる。

上記第6実施例から第11実施例の回転式の多位置制御装置に於る該ニュートラル力F_1は回転子が中立位置から上下に回動しその後電流を切つた時点で発生することが望ましい。即ち、該ニュートラル力F_1は電流を電気導体部5に流している間は弱く電流を切つた時点で最大になるのが理想である。そこで更に改良した装置を第12実施例と

して第12図に示す。第12実施例に於ては、一対の鉄片14a，14bは各々凹状断面にし回転軸10を介して該磁石2a，2b側に固設している。

第13図は、本発明に係る多位置制御装置の第13実施例であつて上記電流力F_1，磁気の吸引反発力F_2及びニュートラル力F_3を利用した摺動式のものの側面断面図を示す。

第13図に於て、符号17は例えばプラスチック製のスペーサで継鉄3a，3bに摺動自在に嵌着されている。又、符号16は軟質磁性体材料でできたボビンであり線輪を図の⊗⊙方向に該ボビンに密に重ねて巻着して電気導体系5を構成している。他は第1図に示す第1実施例と同じである。

上記線輪と鉄製ボビン16で構成された電気導体系5と該プラスチック製スペーサ17とからなる摺動子を図の中立位置N_Tの位置に置き、該電気導体系5に電流を図の⊗⊙方向に流すと電流力F_1が図示矢印方向即ち左手方向に働らき、又、該鉄ボビン16が磁気誘導により電磁石となり左手端部に磁極N極右手端部に磁極S極が現われ該一対の該磁石2a，2bと異極磁極同志の吸引及び同極磁極の反発力F_2が左手方向に働らく。その結果摺動子は左手方向に摺動し該鉄ボビン16の磁極S極が該磁石2a，2bの中心位置即ち中立位置N_Tに来たところで停止する。この時点で磁路面積は鉄ボビン16の右端部が来るため最小となり位置エネルギは最大となるためニュートラル力F_3が右手方向に働らく。このため電流を切ると該ニュートラル力F_3により再び中立位置N_Tに戻るのである。又、電流方向を逆にすると今度は右手方向に電流力F_1，吸引反発力F_2が働らき右手方向に該摺動子が移動する。以上の中立位置及び左右方向の任意のストローク範囲を設定すれば位置制御が実現できるものである。勿論、ばねによる上記可動部材6等外部の復帰手段は必要ない。

第14図は、本発明に係る多位置制御装置の特に第1実施例を走行玩具の可動部材である操舵輪の位置制御に適用した場合を示し、第15図は該多位置制御装置と操舵輪の係合部を示す。

第14図に於て、Aは多位置制御装置を示し符号21a，21bは駆動輪である一対の後輪を示し、例えばモータにより回転駆動される。該モータに流れる電流の方向を切り換えることにより走行玩具は前進及び後退が可能である。符号22a，22bは従動輪たる一対の前輪22a，22bを示し、符号23はシャーシを示す。尚、第14図に於ては玩具のボディを取りはずしているものである。

第15図は、左右一対の前輪と玩具のステアリング機構と本発明に係る多位置制御装置の関連構成を示す。

以上の図面から理解される様に、上記左右一対の前輪の車軸24a，24bは、各々独立に構成した一対の鍵状に形成された軸受台25a，25bに回転自在に軸支されている。又、軸受台25a，25bはビス等を介してその上部の主体が上部に配設された上部フレーム26の先端部の軸孔26a，

26bに嵌合され一方軸受台25a，25bの下部がビス等を介して上記シャーシ23に設けた軸孔23a，23bに嵌合される。このビス等により該上部フレーム26とシャーシ23との間に軸受台25a，25bが介挿される。該ビスが軸受台25a，25bの垂直軸27a，27bとなりこの車軸24a，24bに対する垂直軸を中心に該軸受台25a，25bが回動するのである。尚、図面に示していないが、上部フレーム26の上部には板ばねが設けられており該軸孔26a，26bを嵌合されたビスを当接しサスペンションの役目をする。上記長手板状の上部フレーム26は該シャーシ23に固着された支柱28に例えばネジ等固定手段によりシャーシ23に略水平に固定されている。尚、該車輪22a，22bとその車軸24a，24bは各々一体的に回転する。

更に、各軸受台25a，25bには後方側に突起25a，25bが突設されており、各突起の先端にはピン等を介し長手状の連結棒29と回動自在に連結されている。

該連結棒29は、上記上部フレーム26と略平行に配設されており左右方向に移動することにより各軸受台25a，25bが共通方向に揺動する。従つて車輪22a，22bも共通方向に運動するものである。

即ち、左右一対をなす軸受台25a，25bの後方側端に左右対称な配置で突設された突起25a₁，25b₁の軸孔30a，30bに嵌合したピン31a，31bにより、該連結棒29の両端が連結され、該左右の軸受台25a，25bはいわゆる四節平行リンク機構の一要素として動作する。

一方、上記上部フレーム26の略中央部には垂直上向きに突設されたばね軸32にねじりコイルばね状の戻しばね33の巻端部を挿通し、その略平行な2本のばね脚33a，33bは、上記ばね軸32に近接するように該上部フレーム26に垂直上向きに突設した反力受け軸34及び上記連結棒29の略中央部に突設したばね受けピン29aを挟むように延設されている。

次に、連結棒（タイロッド）29のばね受けピン29aには上記走行玩具のステアリング機構の多位置制御装置15が係合されている。

図示の如く上記連結棒29のばね受けピン29aには例えばアルミニウムハク製導電性な材料でできた長手のステアリングプレート34が着脱自在に嵌合されている。該ステアリングプレート35は円筒状の金属製容器1内に収容された長手の電気導体棒5の側面に該容器1の空隙部分を介して固着され該電気導体棒5と共に移動する。

尚、第14図第15図に示す多位置制御装置の構成は既に説明したので省略する。

尚、上記電気導体棒5の引出線が容器1から出ており該引出線は走行玩具内電気回路（図示せず）から電流をオンオフ及び左右切り替えされるようになっている。

この様な構成の走行玩具に於て、上記電気導体棒5に流れる電流を切り替えることにより従動輪である前輪22a，22bは左右と中立即ち直進位置と3つに方向が変換できるわけである。

又、第14図及び第15図に示した走行玩具に

は第1実施例の多位置制御装置を適用したものであるが第13図に示した第13実施例の装置も同じように適用できる。更に第2実施例から第12実施例までの多位置制御装置を適用する場合、上記連接桿29の中央部にはピン29aの代りに凹状の溝を形成しそこに第7(a)図に示したピン12を嵌合させて上記回転軸10の回動運動に応じて上記連接桿29が往復運動になるように変換するよう構成すればよいものである。

効果

以上、詳細に説明した様に本発明に係る多位置制御装置によれば永久磁石又は電磁石の磁界発生手段により発生した磁界中に設けたエナメル被覆銅線を巻回してなる移動自在の電気導体束に電流を流すことにより発生する力を利用して該電気導体束を移動させ、もつて該電気導体束と連結した物品の可動部材を移動させることが出来る。従つて電流の流す方向を切り換えるだけで該可動部材を少なくとも2つの位置に制御することができるものである。更に電流を切つた時に該可動部材が上記2つの位置の中間位置に静止するように設定すれば3位置制御も可能である。又、電流の大きさを可変すれば3以上の多位置制御が実現できる。上述の如く、簡単な構成で余分なスペースを取らず円滑に可動部材を移動させることができ且つ故障の少なく電流の消費も少ないなど幾多の効果を有するものである。

4 図面の簡単な説明

第1図は、本発明に係る多位置制御装置の第1実施例を示す正面断面図を示し、

第2図は、第1図に示す多位置制御装置の側面図を示し、

第3(a)図は、本発明に係る多位置制御装置の第2実施例の正面断面図を示し、

第3(b)図及び第3(c)図は、本発明に係る多位置制御装置の正面断面図及び側面図を示し、

第4(a)図，第4(b)図及び第4(c)図は本発明に係る多位置制御装置の正面断面図，側面図及び立面図を示し、

第5図は、第5実施例の正面断面図を示し、

第6(a)図及び第6(b)図は、第6実施例の側面断面図と第6(a)図の線I－Iに沿つた正面断面図を示し、

第7(a)図及び第7(b)図は第7実施例の側面断面図と線II－IIに沿つた正面断面図を示し、

第8図から第13図までは各々第8実施例から第13実施例の正面断面図を示し、

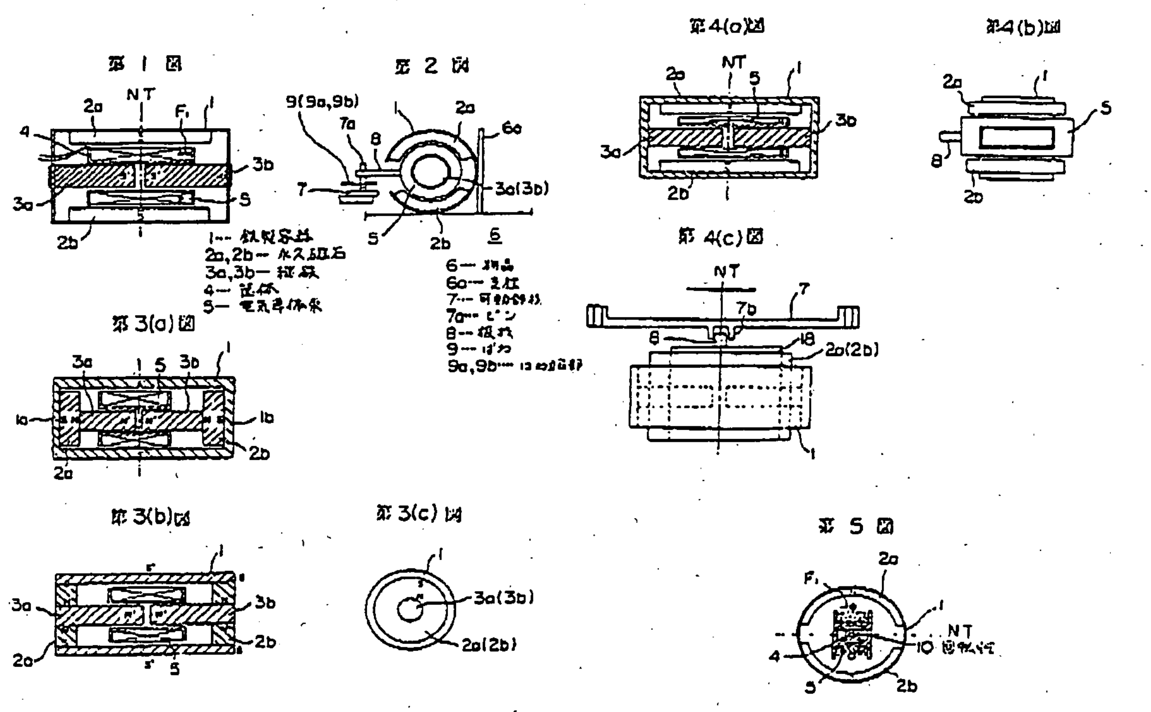
第14図及び第15図は本発明に係る多位置制御装置の第1実施例を走行玩具の連接桿の位置制御に適用した場合の全体斜視図及び要部を示す。

符号の説明

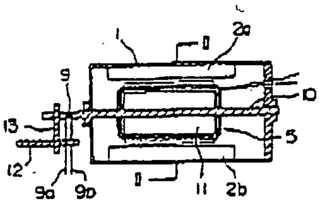
1…容器、2a，2b…永久磁石、3a，3b…継鉄、4…筐体、5…電気導体束、6…物品、6a…支柱、7…可動部材、7a…ピン、8…板材、9…ばね、9a，9b…ばね端部、10…回転軸、11…鉄心、12…ピン、13…軸、14a，14b…鉄片、15…結合ピン、16…鉄製がピン、17…スペーサ、N_0…中立位置、21a，21b…軸端、22a，22b…前輪、23…シャーシ、24a，24b…前輪車軸、25a，25b

…軸受台、26…上部フレーム、27a，27b…垂直軸、28…支柱、29…連結体、29a…ばね受けピン、30a，30b…細孔、31a，31b…ピン、32…ばね軸、33…戻しばね、34…反力受け軸、35…ステアリングプレート。

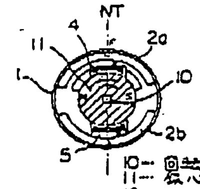
代理人 志賀富士弥



第6(a)図

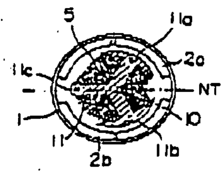


第6(b)図

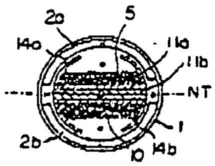


10… 回転軸
11… 鉄心
12… ピン
13… 板

第10図

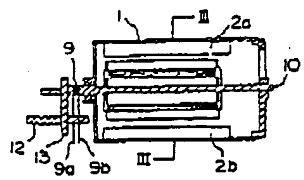


第11図

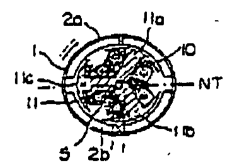


14a, 14b … 鉄片

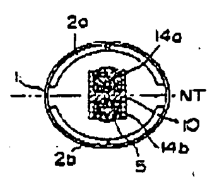
第7(a)図



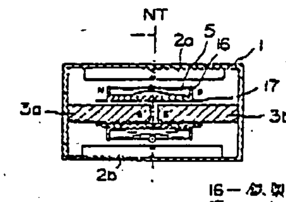
第7(b)図



第12図

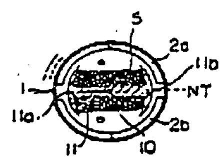


第13図

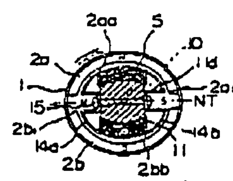


16 — 鉄製ボビン
17 — スペーサ

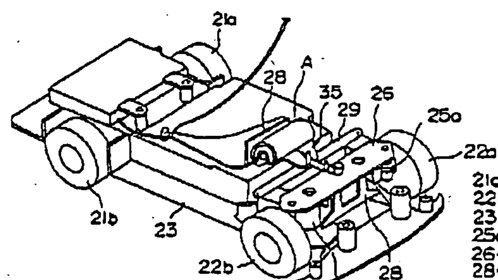
第8図



第9図

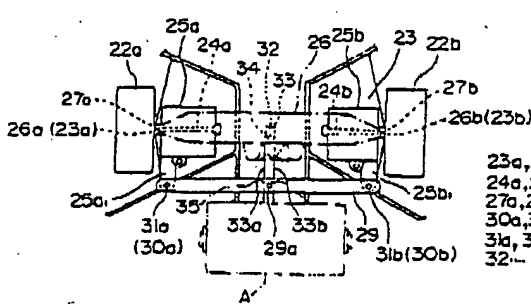


第14図



21a,21b — 後輪
22a,22b — 前輪
23 — シャーシ
25a,25b — 軸受台
26 — 上部フレーム
28 — 支柱
29 — 連結体
29a — ピン
33 — ばね
34 — 反力受け軸

第15図



23a,23b — 軸孔
24a,24b — 車軸
27a,27b — 支点軸
30a,30b — 軸孔
31a,31b — ピン
32 — ばね軸

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(54) Title of the Invention: MULTIPOSITIONAL CONTROL DEVICE

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Specification

1. Title of the Invention

MULTIPOSITIONAL CONTROL DEVICE

2. Patent Claims

(1) A multipositional control device for conducting positional control of a movable member supported by an article so as to move the movable member to the desired position in response to an external force, said multipositional control device characterized in that it comprises:

(a) magnetic field generating means;

(b) an electric conductor bundle engaged with said movable member, composed of a coated electric conductor wire wound so as to cross generally at a right angle the orientation of said magnetic field in the magnetic field generated by said magnetic field generating means, and transferring a force generated by the electric current flowing in said electric conductor wire to said movable member; and

(c) DC current supply means connected to said electric conductor wire for setting the amount and direction of the electric current flowing in said electric conductor wire.

(2) The multipositional control device as described in claim 1, characterized in that said magnetic field generating means comprises:

(a) an elongated permanent magnet; and

(b) a yoke connected to one magnetic pole portion of said permanent magnet and arranged so that a magnetic pole that is different from the below-mentioned magnetic pole appears in a position facing the other magnetic pole portion of said permanent magnet.

(3) The multipositional control device as described in claim 2, characterized in that said electric conductor bundle comprises:

(a) an electric insulating casing slidably attached on the outer periphery of said yoke; and

(b) a coated copper wire wound around said electric insulating casing.

(4) The multipositional control device as described in claim 2, characterized in that

said electric conductor bundle comprises:

(a) an electric insulating casing slidably attached on the outer periphery of said yoke;

(b) a coated copper wire wound around said electric insulating casing;

(c) return means for returning said casing to an almost central position of said yoke when the supply of the electric current to said copper wire is terminated.

(5) The multipositional control device as described in claim 4, characterized in that

said return means comprises:

(a) a coil spring which is wound around a shaft provided in a vertical condition at said article and disposed so that an elastic repulsion force is generated when said electric insulating casing slides according to the direction of the electric current flowing in said copper wire.

(6) The multipositional control device as described in claim 1, characterized in that

said magnetic field generating means is composed of a pair of permanent magnets disposed opposite each other, and

said electric conductor bundle comprises:

(a) a rotary shaft pivotally supported between said pair of magnets and extending along the longitudinal direction thereof;

(b) an insulating casing installed in the longitudinal direction of said rotary shaft; and

(c) a coated copper wire wound along the longitudinal direction of said insulating casing so as to face the magnetic poles of said pair of magnets.

(7) The multipositional control device as described in claim 6, characterized in that

said sliding member is composed of a rod supported on said article so as to move reciprocally inside the prescribed movement region, and

said electric conductor bundle comprises

(a) a pin provided in a vertical conducting parallel to said rotary shaft;

a neutral position in a position facing the gap portions where the end portions of said pair of magnets face each other.

(10) The multipositional control device as described in claim 8, characterized in that

said iron core,

(b) a concave groove located in an almost central position of the rod of said movable member, serving to mate with said pin, and switching the rotary movement of said insulating casing realized when an electric current flows in said copper wire in a straight advance movement; and

(c) a spring that is wound around said rotary shaft, has one end portion thereof squeezing said pin, and acting so that said insulating casing returns to a position facing the magnetic poles of said pair of magnets in the original positions thereof when the electric current flowing in said copper wire is turned off.

(8) The multipositional control device as described in claim 1, characterized in that

said magnetic field generating means comprises:

(a) a pair of permanent magnets; and

(b) an iron core that is mounted on a rotary shaft pivotally supported between said pair of magnets, becomes an electromagnet due to magnetic induction when an electric current is passed in the conductor wires of said electric conductor bundle, and attracts or repulses the magnetic poles of said pair of magnets.

(9) The multipositional control device as described in claim 8, characterized in that

said iron core is composed of an iron member with an almost round cross section that is installed coaxially with said rotary shaft; and

said electric conductor bundle is composed of a coated copper wire that is wound on the outer periphery of said iron member so as to obtain an almost rectangular cross-sectional shape and acts so that the two end portions of said iron core with an almost round cross section on the line perpendicular to the line connecting the center of said almost rectangular cross-sectional shape, said rotary shaft and the center of the cross section of said rotary shaft when the electric current is turned off are stopped in

(a) is divided into three sections in the radial direction of said rotary shaft with an angular spacing of about 120°, with said rotary shaft serving as a center, and each of the three divided end portions is further divided into sections with an approximately crescent-like cross section;

(b) when no electric current flows in the conductor wire of said electric conductor bundle, the

distal ends obtained by aforesaid division into sections with an approximately crescent-like cross section from the first and second end portions among the end portions of the iron core divided as described above into three portions extend along the wall surface of the magnets to a position facing the magnetic poles in almost the central portion of said pair of magnets; and

(c) the third end portion among the end portions of the iron core divided as described above into three portions extends as a neutral position in a position facing one gap where the end portions of said pair of magnets face each other; and

said electric conductor bundle

(a) is composed of a coated copper wire wound around the iron core divided into said three portions so that magnetic poles of the same type are generated at the first end portion and second end portion of said iron core and a magnetic pole of a type different from that of the magnetic pole of said first and second end portions is generated in the third end portion of said iron core.

(11) The multipositional control device as described in claim 8, characterized in that

in said iron core

the central portion thereof is composed of a thin iron sheet mounted on said rotary shaft, and both end portions of said iron sheet extend along the wall surface of said pair of magnets and have an almost crescent-like cross section, and

said electric conductor bundle is composed of a coated copper wire that is wound between the two end portions of said iron sheet, and when no electric current flows, the two end portions of said iron sheet are stopped in a neutral position in a position facing the gap portions where the end portions of said pair of magnets face each other.

(12) The multipositional control device as described in any claim from claims 9 through 11, wherein

said electric conductor bundle comprises a spring mounted on said rotary shaft so that said iron core returns into said neutral position when the electric current flowing in said copper wire is interrupted.

(13) The multipositional control device as described in claim 1, characterized in that

said magnetic field generating means comprises

(a) a pair of permanent magnets; and

(b) an iron core that is mounted on a rotary shaft pivotally supported between said pair of magnets, becomes an electromagnet due to magnetic induction when an electric current is passed in the conductor bundle of said electric conductor bundle, and attracts or repulses the magnetic poles of said pair of magnets, and

(c) a pair of iron pieces that are mounted on said iron cores, in which the portions abutted against said iron core have an almost concave cross section, and that have overhang portions of almost curved cross sections that extend from both end portions of the groove of said concave shape along the wall surfaces of said pair of magnets toward the central magnetic pole thereof, and

said electric conductor bundle

(a) is composed of a coated copper wire wound between the overhang portions with the curved cross sections of said pair of iron pieces and the end portions of said iron core.

(14) The multipositional control device as described in claim 13, characterized in that

the maximum electric current of said electric current supply means is set so that the concave groove portion of said iron piece is returned to the neutral position facing the gap portions where the end portions of said pair of magnets face each other when the electric current flowing in said copper wire is turned off, and rotated through an angle of about 60° from said neutral position and stops when the electric current flows in said copper wire.

(15) The multipositional control device as described in claim 1, characterized in that

said magnetic field generating means is composed of:

(a) a pair of permanent magnets; and

(b) an iron core that is mounted on a rotary shaft pivotally supported between said pair of magnets, has end portions obtained by division into three sections in the radial direction with an angular spacing of about 120°, with said rotary shaft serving as a center, wherein two among the three divided end sections are further divided into sections with an approximately crescent-like cross section, and when no electric current flows in the conductor wires of said electric conductor bundle, the distal ends obtained by the aforesaid division into sections with an approximately crescent-like cross section to a position facing the central magnetic poles of said pair of magnets, and the end portion that was not divided into said sections with an approximately crescent-like cross section is stopped in a neutral position facing one gap portion where the end portions of said pair of magnets face each other; and

said electric conductor bundle

is composed of a coated copper wire wound between the end portions of said iron core so that magnetic poles of different types are generated in the end portion of said iron core that has said approximately crescent-like cross section and the end portion of said iron core that does not have said approximately crescent-like cross section.

(16) The multipositional control device as described in claim 1, characterized in that

position, which is generated when the electric current is turned off, is generated so as to provide no effect on the attraction and repulsion force of the magnetic field and a force produced by the electric current, which is generated when the electric current flows in said electric conductor bundle.

said magnetic field generating means is composed of:

(a) a pair of permanent magnets; and

(b) a pair of iron pieces that are mounted on the rotary shaft pivotally supported between said pair of magnets, become electromagnets due to magnetic induction when an electric current is passed in said electric conductor bundle, and are formed so the magnetic poles generated at this time attract and repulse the magnetic poles of said pair of magnets and the direction of the force generated by this magnetic attraction and repulsion becomes the same as the direction of the force generated by the magnetic field generated by said pair of magnets under the effect of electric current flowing in said electric conductor bundle, and are also formed so as to return into the original neutral position when the electric current flowing in said electric conductor bundle is interrupted.

(17) The multipositional control device as described in claim 16, characterized in that

said pair of iron pieces is composed of

two iron members that are arranged via a gap therebetween around said rotary shaft and extend so as to have a curved cross section from both respective end portions so as to face the wall surfaces of said pair of magnets; and

said electric conductor bundle is composed of a coated copper wire wound between the opposing end portions of said two iron members, while sandwiching said rotary shaft.

(18) The multipositional control device as described in claim 16, characterized in that

said pair of iron pieces has a shape with an H-like cross section, the center thereof being mounted on said rotary shaft.

(19) The multipositional control device as described in claim 18, characterized in that

the thickness of said pair of iron pieces is set according to the value of electric current flowing in said electric conductor bundle and is set so that a force causing a return to the original

(20) The multipositional control device as described in claim 2, characterized in that

said electric conductor bundle is composed of

(a) a spacer member composed of an electricalinsulating material that is slidably mounted along the outer periphery of said yoke;

(b) a bobbin composed of an electric conductor introduced between said pair of magnets and mounted on said spacer member; and

(c) a coated conductor wire wound so that magnetic poles of different types are generated at both end surfaces of said bobbin.

(21) The multipositional control device as described in any claim of claims 1 through 20, characterized in that

said movable member

constitutes a direction change device for changing the direction of a pair of driven wheels of a toy vehicle to the left-right and forward position and is composed of a tie rod, both ends thereof being rotatably supported in shaft bearings engaged with the axles of said drive wheels; and

said electric conductor bundle is coupled with the central portion of said tie rod so that said pair of drive wheels assume a forward position when no electric current flows in said conductor wire.

(22) The multipositional control device as described in any claim of claims 6 through 19, characterized in that

said movable member

constitutes a direction change device for changing the direction of a pair of drive wheels of a toy vehicle to the left-right and forward position and is composed of a tie rod, both ends thereof being rotatably supported in shaft bearings linked to the axles of said drive wheels, and is coupled so that the movement of said tie rod is converted to a reciprocal movement with respect to a rotary movement of said rotary shaft by the pins arranged parallel to said rotary shaft and a groove provided in the central portion of said tie rod.

(23) The multipositional control device as described in any claim of claims 1 through 5 and claim 20, characterized in that said movable member

constitutes a direction change device for changing the direction of a pair of drive wheels of a toy vehicle to the left-right and forward position and is composed of a tie rod both ends thereof being rotatably supported in shaft bearings engaged with the axles of said drive wheels; and

said electric conductor bundle comprises

an electrical insulating sheet mated with pins provided in a vertical condition in the central portion of said tie rod and transferring the reciprocal movement of said electric conductor bundle to said tie rod.

3. Detailed Description of the Invention

Field of Industrial Utilization

The present invention relates to a multipositional control device that is supported on an article so as to provide for the movement to the desired position in response to an external force. In particular, the present invention relates to a multipositional control device suitable for direction change devices that cause simultaneous rotation of axles of drive wheels (front wheels or rear wheels) of toy vehicles such as control cars that are controlled by radio or via a wire and change the direction of the vehicle.

Prior Art Technology

The following direction change devices for radio controlled cars have been suggested: (1) rear wheels serve as drive wheels, the wheel axles are coupled to a differential mechanism (differential gear) and rotary driven with a motor, braking is independent for each axle and is provided by a brake unit composed of an electromagnet and a magnetic material, and the vehicle direction is changed to the left or right by applying a strong braking force exceeding the drive force to the respective one front wheel; or (2) rear wheels serve as drive wheels and are rotated with a motor, a steering mechanism is incorporated by which the vehicle direction change is implemented through the front wheels, which are the drive wheels, with the motor.

However, in the toy vehicle using the method (1), the differential mechanism or electromagnetic brake mechanism was required as a movement direction change device. Those mechanisms took space and increased the cost.

Other drawbacks include a complex structure, difficult production, and high probability of malfunction. On the other hand, in the toy vehicle using the method (2), the drawbacks inherent to method (1) were somewhat overcome, but the direction could not be changed smoothly, significant noise was produced, electric current consumption was high, and the efficiency was poor.

Problems Addressed by the Invention

With the foregoing in view, it is an object of the present invention to resolve the above-described problems and to provide a multipositional control device, more specifically, a highly efficient multipositional control device that takes little space, has a simple structure and low cost, and provides for smooth direction change at a low level of noise and current consumption.

Means to Attain the Object and Operation

In order to resolve the above-described problems, in the multipositional control device for a
Embodiments

The embodiments of the multipositional control device for a movable member of an article in accordance with the present invention will be described hereinbelow with reference to the appended drawings.

movable member of an article in accordance with the present invention, an electric conductor bundle obtained by winding a conductor wire such as enamel-coated copper wire around a casing such as a bobbin is disposed in a constant magnetic field generated by magnetic field generating means composed of a permanent magnet or an electromagnet, and an eclectic current with a variable amplitude or direction is caused to flow in the electric conductor bundle. Thus, if the aforesaid current flows from a DC power supply means, the so-called electric current force F_1 is generated in the direction perpendicular to the current direction and magnetic field direction in the electric conductor bundle. The electric conductor bundle moves under the effect of this electric current force F_1, and the movable member linked to the electric conductor bundle moves to the prescribed position, following the movement of the electric conductor bundle. Therefore, if the amplitude or direction of the electric current is changed appropriately, the movable member can be multipositionally controlled.

Furthermore, if the magnetic field density is increased by adding a yoke to the magnetic field generating means of the above-described configuration, then the electric current force F_1 increases and finer multipositional control can be conducted.

Moreover, if an iron core is introduced into the electric conductor bundle, an electromagnetic is formed by magnetic induction, and the movable member is moved following the movement of the electric conductor bundle by means of a combined force $F_1 + F_2$ of the aforesaid electric current force F_1 and attraction-repulsion force F_2 of the magnetic pole of the aforesaid magnetic field generating means, then the movable member can be moved by a stronger force, and the multipositional control can be conducted at a high speed and with high reliability.

In this case, if the shape of the iron core is selected appropriately, then the electric conductor bundle can return by itself to the original position when the electric current flowing in the electric conductor bundle is interrupted.

In the drawings, identical reference symbols are assigned to identical structural elements.

FIG. 1 is a cross-sectional view illustrating the first embodiment of the multipositional control device in accordance with the present invention.

In FIG. 1, the reference numeral 1 stands for a cylindrical steel container, 2a, 2b, for a pair of

permanent magnets with a C-like cross section that are mounted on the container 1. The magnetic poles are different on the outer and inner sides of the container. Thus, for example, as shown the figure, in the upper magnet 2a, the N pole is on the inner side, and the S pole is on the outer side. In the lower magnet 2b, the S pole is on the inner side, and the N pole is on the outer side. Furthermore, because the container 1 is made of steel, a magnetic circuit is formed, and the magnetic force lines have the highest intensity in the central position of the magnets 2a, 2b. The reference numerals 3a, 3b stand for yokes that are linked to the permanent magnets 2a, 2b via the container 1. It is preferred, that the magnetic circuits be formed so that the opposing gaps be obtained and same poles be obtained on the outer side of the permanent magnets 2a, 2b. The pair of yokes 3a, 3b preferably have a tubular shape coaxial with the container. Furthermore, the reference numeral 4 denotes a cylindrical casing preferably made from a plastic. The casing is inserted between the permanent magnets 2a, 2b and the yokes 3a, 3b and is slidably supported by the yokes 3a, 3b. A fine copper wire preferably provided with an enamel coating (referred to simply as a copper wire hereinbelow) is wound around the casing 4 in a two-phase or double system, and the end portions thereof are led out of the container 1 and connected to an external DC power source (not shown in the figure) via a toggle switch. The switch preferably has a function of conducting ON/OFF switching by the operator and a function of conducting the current direction switching by which the direction of the current flowing into the copper wire is changed. It goes without saying that the function of changing the amplitude of the electric current also can be imparted to the switch. Furthermore, the copper wire may be also connected to a control unit for controlling the electric current flowing in the copper wire by the wireless input signal. The aforesaid wound copper wire and casing 4 constitute an electric conductor bundle 5. The winding direction is generally perpendicular to the spatial magnetic field created by the permanent magnets 2a, 2b and yokes 3a, 3b.

FIG. 2 is a side sectional view of the multipositional control device shown in FIG. 1, this device being fixedly supported by support rod 6a on an article 6, which is a toy vehicle. The aforesaid electric conductor bundle 5 and a pin 7a provided in a vertical condition on the movable member 7, such as a tie rod, of the article 6 are connected by a lightweight longitudinal sheet member 8 via an elongated hole provided in the container 1.

In the multipositional control device of the above-described configuration, when the electric current flowing in the copper wire is turned off, the electric conductor bundle 5 is disposed in the neutral position NT, that is, the position shown in FIG. 1; and if the electric current is caused to flow in the direction shown by symbols © and ⊗ in the figure, then the electric conductor bundle 5 will generate a force F_1 in the direction shown in the figure according to the amplitude of the electric current and intensity of magnetic field. Under the effect of this force F_1, the electric conductor bundle 5 will slide to the right over the yokes 3a, 3b. Therefore, the movable member 7 coupled with the electric conductor bundle 5 will also move to the right. Furthermore, if the direction of the electric current is inverted, the electric conductor bundle 5 will move to the left. Further, if the electric current is turned off, the electric conductor bundle 5 will stop in the assumed position. Therefore, end portions 9a, 9b of a return spring 9 are extended so as to cross the pin 7a in the article 6 so as to provide for forcible return to the neutral portion NT shown in FIG. 1. Under the effect of the spring 9, the movable member 7 and electric conductor bundle 5 are always returned to the neutral position NT when the electric current is turned off. In this way, at least two-positional control of the member can be conducted. If the amplitude of the electric current flowing in the electric conductor bundle 5 is varied, a position control to more than two positions can be conducted.

FIGS. 3(a), 3(b), 3(c), 4(a), 4(b), and 4(c) illustrate other embodiments of the present invention.

Other embodiments relating to combinations of magnets and yokes in the multipositional control device are illustrated by FIGS. 3(a), 3(b), 3(c), and 6.

In the second embodiment shown in FIG. 3(a), a pair of magnets 2a, 2b are disposed on the inner side of the bottom surface wall 1a and upper surface wall 1b of the cylindrical container 1, so that the S poles of the magnets are brought into contact with the wall portion of the container 1 and the N poles face them via the yokes 3a, 3b. In other aspects, the configuration is identical to that of the first embodiment.

In the third embodiment shown in FIG. 3(b) and FIG. 3(c), the bottom surface wall and the upper surface wall 1a, 1b of the cylindrical container 1 are removed, doughnut-like magnets 2a, 2b having an inner diameter identical to that of the container are mated with the respective portions, and the yokes 3a, 3b are mated with the central holes of the magnets 2a, 2b so as to face the almost central portion inside the container. In other aspects, the configuration is identical to that of the first embodiment, similarly to the second embodiment.

In the fourth embodiment shown in FIG. 4(a), 4(b), and 4(c), an angular, more specifically hexagonal container is used instead of the cylindrical metal container 1. Furthermore, the electric conductor bundle 5, magnets 2a, 2b, and yokes 3a, 3b are also formed to have an angular shape. As a result, the stability is further improved, joining to the article 6 is facilitated, and installation of the aforesaid support rod 6a is unnecessary..

Furthermore, in the aforesaid first to fourth embodiments, a pair of permanent magnets 2a, 2b were used as means for generating a magnetic field, but such a selection is not limited, and the magnetic field may be also generated with an electromagnet configuration.

Furthermore, in the aforesaid first to fourth embodiments, yokes 3a, 3b of separate configurations were used, but it goes without saying that a configuration may also be employed in which one permanent magnet is used and the electric conductor bundle 5 is slidably supported along the longitudinal surface of this permanent magnet.

As for the movable member 7 of the present embodiment, the sheet member 8 is engaged with the concave groove 7b in the central position of the movable member 7.

FIG. 5 is a front view illustrating the fifth embodiment of the multipositional control device in accordance with the present invention.

In the present embodiment, a rotary shaft 10 is pivotally supported along the central axis of the container 1, and the casing represented by the reference numeral 4 and having an almost rectangular cross section is fixed. The respective N poles and S poles of the permanent magnets 2a, 2b are generated inside the container. Further, the copper wire is wound along the longitudinal direction of the casing.

If an electric current flows in the direction shown by ⊗ and ⊙ in the position shown in the figure, the aforesaid force F_1 is generated, and the casing 4 rotates counterclockwise together with the rotary shaft 10. Furthermore, if the electric current flows in the opposite direction, the casing rotates clockwise. If the rotary movement of this rotary shaft 10 and the casing is appropriately transferred to the movable member 7, the multipositional control becomes possible. Furthermore, when the

movable member 7 moves reciprocally, a mechanism for converting the rotary movement into the reciprocal movement may be provided. In the present embodiment, too, return means such as a spring may be set so that the electric conductor bundle 5 always comes to the position shown in FIG. 5 when no electric current flows therein.

FIG. 6(a) and FIG. 6(b) illustrate the sixth embodiment of the multipositional control device in accordance with the present invention.

In the present embodiment, a soft iron core 11 with a round cross section is installed around the rotary shaft 10, contrasting with the configuration of the casing 4 described in the fifth embodiment. The aforesaid copper wire is wound in the diameter direction of the iron core 11. In the end portion of the rotary shaft 10, which is similar to that of the fifth embodiment, an elongated plate 13 is extended perpendicular to the rotary shaft 10 and a pin 12 is arranged in a vertical position parallel to the rotary shaft 10 at this end portion.

In the multipositional control device of the present embodiment having the above-described configuration, as shown in FIG. 6(b), an electric current flows in the direction shown by the symbol ⊗ in the zone of the electric conductor bundle 5 facing the N side of the upper magnetic poles of the aforesaid pair of magnets 2a, 2b. On the other hand, the electric current represented by the symbol ⦿ flows in the zone of the electric conductor bundle 5 facing the S side of the lower magnetic poles of the aforesaid pair of magnets 2a, 2b. As a result, an electric current force F_1 similar to that of the aforesaid embodiments is generated in the counterclockwise direction, that is, in the direction perpendicular to the direction of the electric current flowing in the electric conductor bundle 5 and the direction of magnetic flux between the pair of magnets 2a, 2b. Furthermore, magnetic poles N and S are generated in the left and right end surfaces of the iron core 11. Thus, if an electric current is passed through the aforesaid copper wire forming the electric conductor bundle 5, then a magnetic field is generated and the magnetic induction action of the magnetic field produces different magnetic poles corresponding to the direction of electric current in the left and right end surfaces of the iron core and the iron core itself becomes an electromagnet. As a result, the magnetic pole N that appeared on the left end surface and the magnetic pole S on the lower side of the pair of magnets 2a, 2b are mutually attracted, and also repulsed from the magnetic poles N on the upper side of the magnets 2a, 2b. On the other hand, the magnetic pole S that appeared on the right end side and the magnetic pole S on the lower side of the pair of magnets 2a, 2b are mutually repulsed, and also attracted to the magnetic poles N on the upper side of the pair of magnets 2a, 2b. The direction of those attraction-repulsion forces F_2 is counterclockwise, like the direction of the aforesaid electric current force F_1. Therefore, under the effect of the combined force $F_1 + F_2$, the rotary shaft 10, together with the electric conductor bundle 5 and the iron core 11, rotates counterclockwise, that is, in the direction shown by the solid line in the figure. At this time, the pin 12 installed parallel to the rotary shaft 10 rotates following the counterclockwise rotation of the rotary shaft 10 and the movable member 7 moves accordingly. Thus, it moves to the right. Further, as for the rotation distance of the rotary shaft 10, this rotation is set to a maximum of 90° by the number of turns of the copper wire in the electric conductor bundle 5 and the amplitude of the electric current, that is, till the magnetic poles N, S appearing on the left and right end surfaces of the iron core 11 come to the positions in which they face the magnetic poles N, S located in the center of the pair of magnets 2a, 2b.

In this state, the toggle switch is switched off. Thus, if the electric current flowing in the copper wire of the electric conductor bundle 5 is turned off, in the present embodiment, the structure stops in the present position because the below-described neutral force F_3 does not act.

Accordingly, in the present embodiment, the rotary shaft 10 and the convex portion provided in the article 6 are returned to the position NT shown in FIG. 6(b) by the elastic force of the coil-like spring 9 provided in a tensioned state on the pin 12. On the other hand, if an electric current is passed in the direction opposite to the above-described direction in the zone of the electric conductor bundle 5 facing the magnetic pole N, which is on the upper side of the pair of magnets 2a, 2b, then the electric current force F_1 will act in the clockwise direction, that is, the direction opposite to that of the above-described case, the magnetic poles on the left and right end surfaces of the iron core 11 become inversed with respect to the aforesaid poles, the attraction-repulsion forces F_2 also acts clockwise, and eventually the rotary shaft 10 rotates clockwise, that is, in the direction shown by a dotted line arrow in the figure. Therefore, under the effect of the return spring 9, the electric conductor bundle 5 that came into the neutral position will move in the reverse direction, that is, to the left.

As described hereinabove, the multipositional control device of the present

embodiments makes it possible to conduct a multipositional control of the movable member 7. Furthermore, in the present embodiment, the attraction-repulsion force F_2 was used in addition to the electric current force F_1. Therefore, the force causing the movable member 7 to move had greater intensity. As a result, the movable member 7 could be moved with a higher speed and reliability.

The electric conductor bundle 5 and iron core 11 have to be set into the positions shown in FIG. 6(b) in a state in which no electric current flows in the copper wire. This is because when the electric current flows in a neutral position, which is assumed to correspond to a state in which the electric conductor bundle 5 shown in FIG. 6(b) faces the gap side of the pair of magnets 2a, 2b and the left and right end surfaces of the iron core 11 are disposed opposite the central magnetic pole side of the magnets 2a, 2b, it is impossible to establish the rotation direction of the rotary shaft 22 and the aforesaid electric current force F_1 is not added to the direction of the attraction-repulsion force F_2.

FIG. 7(a) and FIG. 7(b) illustrate the seventh embodiment of the multipositional control device in accordance with the present invention.

In the present embodiment, the method of engagement with the movable member 7 is identical to that of the above-described fifth and sixth embodiments, and the explanation thereof is therefore omitted.

As shown in FIG. 7(b), the iron core 11 comprises three end portions 11a, 11b, 11c provided in a condition of extending the rotary shaft 10 in the radial direction with a spacing of about 120°C, those portions having a crescent-like cross-sectional shape. The edge of the crescent-like cross section of the end portion 11a, which is one of those end portions, is generally set to face the central magnetic pole N on the upper side of the pair of magnets 2a, 2b. The other edges of the crescent-like cross section are set to face the right ends on the upper side of the magnets 2a, 2b. Further, the edge of the crescent-like cross section of the end portion 10b is set to face right ends on the lower side of the magnets 2a, 2b. The other edges of the crescent-like cross section are set to face the central magnetic poles S on the lower side of the magnets 2a, 2b. Both edges of the crescent-like cross section of the end portion 10c are arranged opposite the intermediate position between the left end portions and central magnetic poles N and S of the magnets 2a, 2b.

Further, the copper wire is wound, for example, along the longitudinal direction of the iron core (see FIG. 7(b)), from the right side of the end portion 23a in the direction shown by the symbol ◎, then till the left side of the end portion 11a in the direction shown by the symbol ⊗, then from the portion shown by the symbol ◎ on the right side of the end portion 11a, from the direction shown by the symbol ⊗ on the upper side of the end portion 11c in the direction shown by the symbol ◎ on the lower side of the end portion 11c, in the longitudinal direction of the iron core, and then from the direction shown by the symbol ⊗ on the upper side of the end portion 11b in the direction shown by the symbol ◎ on the lower side of the end portion 11b along the longitudinal direction of the iron core. Finally, the copper wire is lead to the outside of the container 1 through the opening in the lid body 14 of the container 1. Therefore, if an electric current is passed in the ◎ direction on the right side of the end portion 10a, the magnetic pole S is produced by magnetic induction on the end portion 10a, the S pole is produced on the end portion 10b, and the N pole is produced on the end portion 10c.

As described hereinabove, when an electric current is passed, a magnetic pole S is generated by magnetic induction in the end portions 11a, 11b of the iron core 11, and a magnetic pole N is generated in the portion 11c. On the other hand, the electric current force F_1 differs in the different portions of the magnetic conductor bundle 18 [sic] depending on the direction of winding around the portions 11a, 11b, 11c, but the resulting effect for the entire structure is in the counterclockwise direction, that is, the direction shown by the solid line arrow in FIG. 7(b). Furthermore, the attraction force between the different poles, which acts between the poles of the portions 11a, 11b, 11c generated by the magnetic induction and the magnetic poles of the pair of magnets 2a, 2b and the repulsion force F_2 between the magnetic poles of the same type act in the direction identical to that of the aforesaid electric current force F_1. Therefore, the electric conductor bundle 5 and iron core 11 will rotate counterclockwise under the effect of the force representing the combination of the electric current force F_1 and the attraction-repulsion force F_2. The maximum movement distance in the counterclockwise direction is from a state in which the end portion 23c is in a neutral position NT of iron core 11, that is, the opposing position of the pair of magnets 2a, 2b via the left gap, to the state in which the end portion 11c comes to the position facing the central magnetic pole S on the lower side of the pair of magnets 2a, 2b where the density of magnetic force lines is the highest. In this case, because of the two projections of the crescent-like

cross sections of the end portion 11c, the surface area opposite the central magnetic pole S of the lower magnet 2a is larger than the cross sectional area of the iron core. Therefore, the number of magnetic force lines passing through the portion 11c increases. Therefore, the below-described neutral force F_3 is not generated because the potential energy of the system composed of the pair of magnets 2a, 2b and the iron core 11 is low. As a result, this state is canceled if the electric current flowing in the copper wire of the electric conductor bundle 5 is turned off. For this reason, a spring 9 identical to that of the above-described fifth and sixth embodiments is provided and the force of this spring is used to return the rotor composed of the electric conductor bundle 5, iron core 11, and rotary shaft 10 to the aforesaid neutral position (position shown in FIG. 7(b)) NT.

Further, if the electric current flowing in the copper wire constituting the electric conductor bundle 5 flows in the direction inversed with respect to the above-described direction, then, the N poles appear at the end portions 11a, 11b of the iron core 11, and the S pole appears at the end portion 11c. In this case, the electric current force F_1 and the magnetic attraction-repulsion force F_2 are both oriented in the clockwise direction, that is, the direction shown by a dot line arrow in FIG. 7(b). Therefore, the maximum rotation of the above-described rotor in the clockwise direction is 90°. Therefore, it is possible to obtain the rotation of the rotor in a maximum stroke range of 180 degrees, and the positional control of the movable member 7 can be conducted.

FIG. 8 illustrates the eighth embodiment of the multipositional control device in accordance with the present invention. The configuration from the container 1, magnets 2a, 2b and rotary shaft 10 to the movable member 7 is identical to that of the above-described embodiments, and the explanation thereof will be omitted.

In the present embodiment, an iron core configuration may be considered in which the two end portions 11a, 11b on the right side of FIG. 7(a) and FIG. 7(b), which illustrate the seventh embodiment, are joined and disposed on the opposite side of the left end portion 11c.

Further, the rotor is obtained by winding the electric conductor bundle 5 composed of the copper wire in the longitudinal direction of the container 1 between the end portion 11a and 11c of the iron core 11 having the crescent-like cross section, and the rotor is disposed in the neutral position NT shown in FIG. 8. If from the neutral position state shown in FIG. 8, an electric current is passed in the direction shown by the symbol ⊗ on the upper side of the electric conductor bundle 5 shown in the figure, that is, on the side opposing the upper side 2a of the pair of magnets 2a, 2b, and in the direction shown by the symbol ⦿ on the lower side of the electric conductor bundle 5, that is, on the side opposing the lower side 2a of the pair of magnets 2a, 2b, then the N pole will be created by magnetic induction on the end portion 11a on the left side of the iron core 11, and the S pole will appear on the end portion 11b on the left side, a magnetic attraction-repulsion force F_2 with the magnets 2a, 2b will be generated together with the electric current force F_1 generated in the counterclockwise direction, and the rotor will rotate around the rotary shaft 10 in the direction shown by a solid line arrow in the figure, that is, in the counterclockwise direction. Further, if the direction of electric current is inverted with respect to the above-described direction, the rotation will be from the neutral position NT shown in the figure in the direction shown by a dotted-line arrow, that is, the clockwise direction, around the rotary shaft 10. It goes without saying, that the electric current force F_1 and magnetic attraction-repulsion force F_2 cause the rotation against the elastic force of the spring (not shown in the figure) setting the rotor in the neutral position NT shown in the figure.

FIG. 9 shows the ninth embodiment of the multipositional control device in accordance with the present invention.

In this embodiment, a pair of neutral iron pieces 14a, 14b with an almost crank-like cross section shown in FIG. 9 are linked with a left-right symmetry by caulking with the joining pin 15 to the elongated hole 11d provided in the iron core 11. Furthermore, the electric conductor bundle 5 obtained by winding the copper wire on the facing portions of the neutral iron pieces 14a, 14b is formed on the outer periphery of the iron core 11, the center of the iron core 11 is engaged via the joining pin 15 with the central axial hole (not shown in the figure) of the container 1 and the axial hole of the lid body (not shown in the figure) on the rear side of the container 1. The rotor composed of the iron core 11, neutral iron pieces 14a, 14b, electric conductor bundle 5, rotary shaft 10, and joining pin 15 is disposed so as to come into the neutral position NT shown in FIG. 9. At this time, the central recess of one of the neutral iron pieces 14a, 14b is positioned in the opposing parts of the end portions of the pair of magnets 2a, 2b.

In the state shown in FIG. 9, if an electric current is caused to flow in the direction shown by

the symbol ⊗ in the electric conductor bundle 5 facing the upper side 2a of the pair of magnets 2a, 2b, and in the direction shown by the symbol ⊙ in the electric conductor bundle 5 facing the lower side 2b, then a magnetic path will appear in the neutral iron pieces with the crank-like cross section from the left-right cut portion of the iron core 11, and magnetic poles N and S will appear, as shown in the figure, along the iron pieces 14a, 14b. Similarly to the above-described embodiments, the electric current force F_1 and the force F_2 caused by attraction between the magnets of opposite types and repulsion between the magnets of the same type will be generated, and the rotor composed of the electric conductor bundle 5 and neutral iron pieces 14a, 14b will rotate in the direction shown by the solid line in the figure, that is, in the counterclockwise direction. Further, according to the quantity of the electric current, the recesses of the pair of neutral iron pieces 14a, 14b will come to the respective positions facing the N pole and S pole shown in the figure, which are the portions with the highest density of magnetic force lines in the pair of magnets 2a, 2b, that is, the central magnetic pole of the magnets, those positions corresponding to 90°. As for the cross-section area of the magnetic path at this time, the magnetic resistance decreases because the difference between the cross-section area of the recesses of the neutral iron pieces 14a, 14b and the cross-section area of the iron core increases. Therefore, because the potential energy of the system composed of the pair of magnets 2a, 2b and the rotor decreases, when the electric current is turned off in this position, the rotor does not return to the original neutral position NT. The so-called dead center in which the potential energy of the system reaches maximum is attained when the end portions 14aa, 14bb on the circular arc of the cross section of the pair of neutral iron pieces 14a, 14b come close to the end portions $2a_1$, $2b_1$ of the magnets 2a, 2b.

Thus, when the neutral position NT is assumed at 0°, the dead center generally becomes close to 60°. At this time, the circular arc portion of the cross section of the pair of neutral iron pieces 14a, 14b comes to the position facing the central magnetic poles N and S of the pair of magnets 2a, 2b. Therefore, the difference between the cross-section area of the circular arc portion of the neutral iron pieces and the cross-section area of the iron core reaches minimum and the magnetic resistance increases (the magnetic resistance is proportional to the length of the magnetic path and inversely proportional to the cross-section area of the magnetic path). Therefore, the potential energy of the system reaches maximum. Further, when the rotor is in the neutral position NT shown in FIG. 9, a magnetic path is formed via the end portions of the pair of magnets 2a, 2b and the concave portions of the pair of neutral iron pieces 14a, 14b. However, because the cross-section area in the longitudinal direction of the figure surface is large, the magnetic resistance is small. Therefore, the potential energy of the system is small. For this reason, when the rotor rotates through 60°, that is, reaches the aforesaid dead center, a neutral force F_3 is generated, this force acting in the direction of return to the position with a low potential energy, that is, to the above-mentioned neutral position NT. Therefore, if settings are made so that the rotor stops once it reaches the aforesaid dead center, when the electric current is turned off, the rotor naturally returns to the neutral position NT under the effect of the neutral force F_3. In the case of the present embodiment, the special return means for forcible return of the rotor to the neutral position NT, such as the spring 9 such as described in the aforesaid embodiments, becomes unnecessary. Furthermore, if the electric current is interrupted, the rotor rotates from the neutral position NT in the direction shown by a dotted-line arrow in the figure, that is, in the clockwise direction. Therefore, if a stroke range from the neutral position NT to approximately 60° in both directions will be used, the positional control of the movable member can be realized.

FIG. 10 is a cross-sectional view illustrating the tenth embodiment of the multipositional control device in accordance with the present invention. The internal configuration of the multipositional control device of this embodiment is close to that of the seventh embodiment shown in FIG. 7(a) and FIG. 7(b). Thus, it corresponds to a configuration in which the protrusion with a crescent-like cross section that is present in the end portion 11c of the iron core shown in FIG. 7(b) is removed. Furthermore, in the present embodiment, it is not necessary to provide the rotary shaft 10 with a return means, such as the spring 9 similar to that of the ninth embodiment.

Further, in the case of this embodiment, if an electric current flows, as described in the sixth embodiment, in the directions represented by the symbols ⊗ and ⊙ in the figure, then, the respective magnetic poles S, S, and N appear at the end portions 11a, 11b, 11c of the iron core, and the rotor rotates in the counterclockwise direction. However, if the end portion 11c shifts from the neutral position NT to the 90° position, the cross-section area of the magnetic path reaches minimum, the magnetic

resistance thereof reaches maximum, and therefore the potential energy of the system assumes a maximum value. Therefore, the neutral force F_3 is generated, and if the electric current is turned off, the rotor returns to the neutral position. In the present embodiment, as described hereinabove, the rotation proceeds up or down to an angle of 90°, but it goes without saying that the stroke range may be also set to 60° up and down, as in the tenth embodiment.

FIG. 11 is a cross-sectional view of the eleventh embodiment of the multipositional control device in accordance with the present invention.

The maximum stroke range of the present embodiment is 90° up and down from the neutral position NT, similar to the above-described tenth embodiment. It goes without saying, that the positional control of the movable member 6 can be also conducted by setting a range of 60° up and down from the neutral position as the stroke range.

When the pair of iron cores 11a, 11b placed between the pair of neutral iron pieces 14a, 14b are removed and the rotor is rotated through 90°, the magnetic attraction-repulsion force is weakened and the neutral force F_3 is increased.

The neutral force F_3 in the multipositional control device of the rotary system of the sixth to eleventh embodiments is preferably generated at the instant of time when the rotor is rotated up or down from the neutral position and then the electric current is turned off. Thus, in a perfect mode, the neutral force F_3 is weak while an electric current flows in the electric conductor bundle 5 and reaches maximum at the instant of time when the electric current is turned off. A device that was accordingly further improved is shown in FIG. 12 as a twelfth embodiment. In the twelfth embodiment, the pair of iron pieces 14a, 14b are formed to have a concave cross section, a rotary shaft 10 is placed therebetween, and the iron pieces are provided in an extending condition to the magnets 2a, 2b.

FIG. 13 is side sectional view of the thirteenth embodiment of the multipositional control device in accordance with the present invention. It is a sliding system using the electric current force F_1, magnetic attraction-repulsion force F_2, and neutral force F_3.

In FIG. 13, the reference symbol 17 stands for a spacer made, for example, from a plastic and slidably installed on the yokes 3a, 3b. Further, the reference numeral 16 stands for a bobbin made from a magnetic material such as iron. An electric conductor bundle 5 is obtained by tightly winding a copper wire in a multilayer fashion on the bobbin in the directions represented by the symbols ⊗ and ⊙ in the figure. In all other aspects, this embodiment is identical to the first embodiment illustrated by FIG. 1.

If a sliding member composed of the electric conductor bundle 5 comprising the aforesaid copper wire and iron bobbin 16 and the plastic spacer 17 is placed into the neutral position NT shown in the figure and an electric current is passed into the electric conductor bundle 5 in the directions represented by the symbols ⊗ and ⊙ in the figure, then the electric current force F_1 will act in the direction shown by a solid-line arrow in the figure, that is, towards the left. Furthermore, under the effect of magnetic induction, the iron bobbin 16 becomes an electromagnet, a magnetic pole N appears at the left end portion, a magnetic pole S appears at the right end portion, and the attraction force acting between the magnetic poles of different types and the repulsion force F_2 acting between the magnetic poles of the same type (with respect to the pair of magnets 2a, 2b) act toward the left. As a result, the sliding member slides towards the right and stops when the magnetic pole S of the iron bobbin 16 comes to the central position of the magnets 2a, 2b, that is, to the neutral position NT. At this point in time, the surface area of the magnetic pole reaches minimum because of the arrival of the right end portion of the iron bobbin 16 and the potential energy assumes a maximum value. As a result, the neutral force F_3 acts towards the right. Therefore, if the electric current is turned off, the sliding member again returns to the neutral position NT under the effect of the neutral force F_3. Further, if the direction of electric current is inverted, the electric current force F_1 and attraction-repulsion force F_2 act towards the right and the sliding member moves to the right. The positional control can be realized by setting the aforesaid neutral position and stroke ranges for the movement towards the left and right. It goes without saying that no external return means for the movable member 6, such as a spring, is required.

FIG. 14 illustrates the case in which the first embodiment of the multipositional control device in accordance with the present invention is applied to positional control of a tie rod that is a movable member of a toy vehicle. FIG. 15 illustrates the engagement state of the multipositional control device and the tie rod.

In FIG. 14, the reference symbol A stands for a multipositional control device, and 21a, 21b, for a pair of rear wheels, which are the drive wheels rotated, for example, from a motor. The toy vehicle

can be moved forward or backward by switching the direction of electric current flowing in the motor. The reference symbols 22a, 22b stand for a pair of front wheels 22a, 22b serving as drive wheels, and 23, for a chassis. Note that in the structure shown in FIG. 14, the vehicle body is removed.

FIG. 15 shows the configuration illustrating the relation of the left and right front wheels, the steering mechanism of the toy, and the multipositional control device in accordance with the present invention.

The aforesaid figures show that the axles 24a, 24b of the left and right front wheels are rotatably supported on bearing stands 25a, 25b formed in a pair of boxes having independent structure. Furthermore, the upper lids of the bearing stands 25a, 25b are mated, for example, with bolts, with the axle holes 26a, 26b of end portions of the upper frame disposed in the upper part of the stands. On the other hand, the lower portions of the bearing stands 25a, 25b are mated with the axle holes 23a, 23b provided in chassis 23, for example, via bolts. The bearing stands 25a, 25b are inserted between the chassis 23 and the upper frame 26, for example, with the bolts. The bolts become the vertical shafts 27a, 27b of the bearing stands 25a, 25b, and the bearing stands 25a, 25b rotate round those vertical shafts with respect to the axles 24a, 24b. Note that a sheet spring is provided in the upper part of the upper frame 26, and the bolts mated with the axle holes 26a, 26b are brought into contact with the spring, thereby creating a suspension. The upper frame 26 in the form of an elongated sheet is fixed almost horizontally with the chassis 23 with fixing means such as screws to the support rod 28, which is fixedly mounted on the chassis 23. Further, the wheels 22a, 22b and axles 24a, 24b thereof rotate as respective integrated units.

Protrusions 25a, 25b are provided vertically on respective bearing stands 25a, 25b, and the elongated connecting rod 29 is rotatably linked to the distal ends of the protrusions, for example, via pins.

The tie rod 29 is installed almost parallel to the upper frame 26, and when it moves to the left or to the right, the bearing stands 25a, 25b move together in the respective direction. Therefore, the axles 22a, 22b also move together in the respective direction.

Thus, both ends of the tie rod 29 are linked by the pins 31a, 31b mated with the axle holes 30a, 30b of protrusions $25a_1$, $25a_2$ provided vertically and with a left-right symmetry at the rear side ends of the bearing stands 25a, 25b forming a left-right pair, and the left and right bearing stands 25a, 25b operate as an element of the so-called four-joint parallel-link mechanism.

On the other hand, a base end portion of a return spring 33 in the form of a coil spring is wound around a spring shaft 32 provided in a protruding condition upward in the vertical direction in almost the central portion of the upper frame 26. The two, near-parallel spring arms 33a, 33b thereof are provided in an extending condition so as to sandwich a spring receiving pin 29a provided in the protruding condition in almost the central portion of the aforesaid connecting rod and a shaft 34 for receiving the repulsion force, which is provided in a protruding condition upward in the vertical direction in the upper frame 26 so as to be adjacent to the spring shaft 32.

The multipositional control device 15 of the steering mechanism of the above-described toy vehicle is engaged with the spring receiving pin 29a of the tie rod 29.

As shown in the figure, an elongated steering plate 34 manufactured from a lightweight material such as an aluminum brush is detachably mated with the spring receiving pin 29a of the aforesaid tie rod 29. The steering plate 35 is fixed via a gap portion of the container 1 to the side surface of the elongated electric conductor bundle 5 accommodated inside the cylindrical metal container 1 and moves together with the electric conductor bundle 5.

The configuration of the multipositional control device shown in FIG. 14 and FIG. 15 has already been described, and the explanation thereof will be omitted.

The lead-out wire of the electric conductor bundle 5 is lead out from the container to conduct ON/OFF and left-right switching of the electric current supplied from a DC power source (not shown in the figure) such as a battery or the like.

In the toy vehicle of such a configuration, when the electric current flowing in the electric conductor bundle 5 is switched, the front wheels 22a, 22b serving as drive wheels are controlled into three positions: left, right, and neutral, that is, forward advance positions.

In the toy vehicle shown in FIG. 14 and FIG. 15, the multipositional control device of the first embodiment was used, but the device of the thirteenth embodiment shown in FIG. 13 can be used in the same manner. Furthermore, when the multipositional control devices of the second to twelfth embodiments are used, a configuration may be used in which a concave groove is formed instead

of the pin 29a in the central portion of the tie rod 29, the pin 12 shown in FIG. 7(a) is mated with the groove, and the tie rod 29 is controlled to execute a reciprocal movement following the rotary movement of the rotary shaft 10.

Effect

As described hereinabove, with the multipositional control device in accordance with the present invention, a movable electric conductor bundle obtained by winding an enameled copper wire is provided in a magnetic field generated with magnetic field generating means such as a permanent magnet or electromagnet and the electric conductor bundle is moved by using a force generated when an electric current is passed through the electric conductor bundle, thereby causing the movement of the movable member of the article linked to the electric conductor bundle. Therefore, the movable member can be controlled to at least two positions by switching the direction of the electric current. Moreover, a three-position control is also possible if settings are made such that when the electric current is turned off, the movable member stops in a neutral position between the aforesaid two positions. Moreover, multipositional control to three and more positions can be realized by varying the amplitude of the electric current. As described hereinabove, the movable member can be moved smoothly with a simple configuration, without taking extra space, the probability of failures is small, and the electric current consumption is low.

4. Brief Description of the Drawings

FIG. 1 is a front sectional view illustrating the first embodiment of the multipositional control device in accordance with the present invention.

FIG. 2 is a side surface view of the multipositional control device shown in FIG. 1.

FIG. 3(a) is a front sectional view of the second embodiment of the multipositional control device in accordance with the present invention.

FIGS. 3(b) and FIG. 3(c) are a front sectional view and a side surface view of the multipositional control device in accordance with the present invention.

FIG. 4(a), 4(b), and 4(c) are the front sectional view, side view, and perspective view of the multipositional control device in accordance with the present invention.

FIG. 5 is a front sectional view illustrating the fifth embodiment.

FIG. 6(a) and FIG. 6(b) are a side sectiona view of the sixth embodiment and a front sectional view along the line II-II in FIG. 6(a).

FIG. 7(a) and FIG. 7(b) are a side sectiona view of the seventh embodiment and a front sectional view along the line III-III.

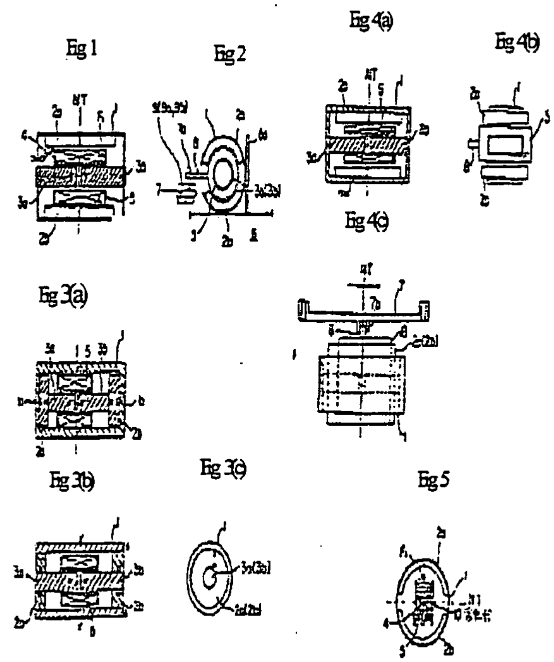
FIGS. 8 through 13 are front sectional views of the eighth to thirteenth embodiments, respectively; and

FIG. 14 and FIG. 15 show the entire perspective view and main components relating to the application of the first embodiment of the multipositional control device in accordance with the present invention to the positional control of the tie rod of the toy car.

(Keys)

1 - container; 2a, 2b - permanent magnet; 3a 3b - yoke; 4 -casing; 5 - electric conductor bundle; 6 - article; 6a - support rod; 7 - movable body; 7a - pin; 8 - sheet-like material; 9 - spring; 9a, 9b - spring en portion; 10 - rotary shaft; 11 - iron core; 12 - pin; 1: - plate; 14a, 14b - iron piece; 15 - connecting pin; 1 - iron bobbin; 17 - spacer; NT - neutral position; 21 21b - rear wheels; 22a, 22b - front wheels; 23 - chassis; 24a, 24b - front wheel axles; 25a, 25b - bearing stand; 26 - upper frame; 27a, 27b - vertical shaft; 28 - support column; 29 - tie rod; 29a - spring receiving pin; 30a, 30b - axle holes; 31a, 31b - pin; 32 - spring shaft; 33 - return spring; 34 - repulsion force receiving shaft; 35 - steering plate.

Patent Representative: Fujiya Shiga, Patent Attorne [stamp]



Key:
Fig.1
1 container;
2a, 2b-permanent magnet;
3a, 3b - yoke;
4-casing;
5-electric conductor bundle

Fig. 2
6-article;
6a-support rod;
7-movable body;
7a-pin;
8-sheet-like material;
9-spring;
9a, 9b-spring end portion

Fig.6(a)

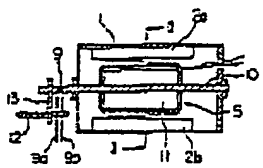


Fig. 7 (a)

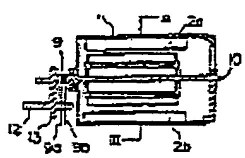


Fig. 8

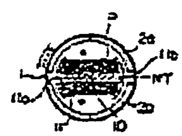


Fig. 10

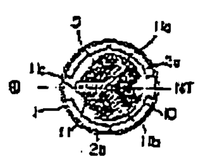
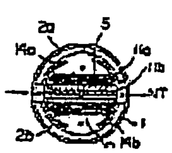


Fig. 11



14a,14b iron piece

Fig. 12

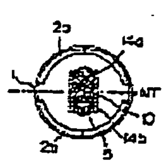
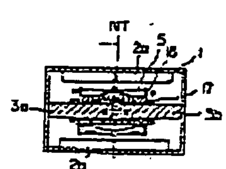
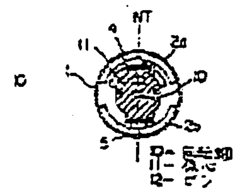


Fig. 13



16-iron bobbin
17-spacer

Fig. 6(b)



Key: 6b
10-rotary shaft;
11-iron core
12-pin
13-plate

Fig. 7(b)

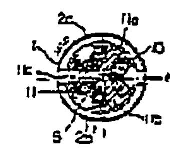


Fig. 9

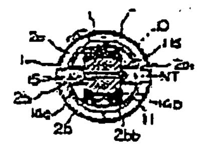


Fig. 14

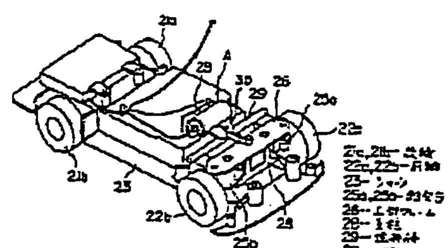
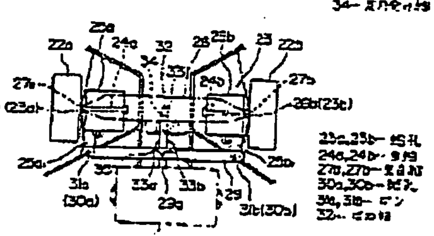


Fig. 15



Key:
Fig. 14
23a, 23b-axle holes
24a, 24b-axles
27a, 27b - vertical shaft
30a, 30b -axle holes31a, 31b-pin
32-spring shaft.
Fig. 15
21a, 21b-rear wheels
22a, 22b front wheels
23-chassis
25a, 25b bearing stands
26-upper frame
28-support column
29-tie rod29a-pin
33-spring
34-repulsion force receiving shaft